INSTRUMENTS and AUTOMATION

Including: The Journal of the SCMA and Simulation Council Newsletter

SIMULATION COUNCIL

AUTOMATION SHOW ISSUE

also in this issue:

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Automation—The substitution of mechanical, pneumatic, hydraulic, electrical and electronic devices for human organs of decision and effort.

Automation—The science and art of manufacturing products with minimum labor, effort and cost, and maximum efficiency.

Automation—The elimination of repetitive, onerous, dangerous and trivial labor, mental or physical, from the realm of human endeavor.

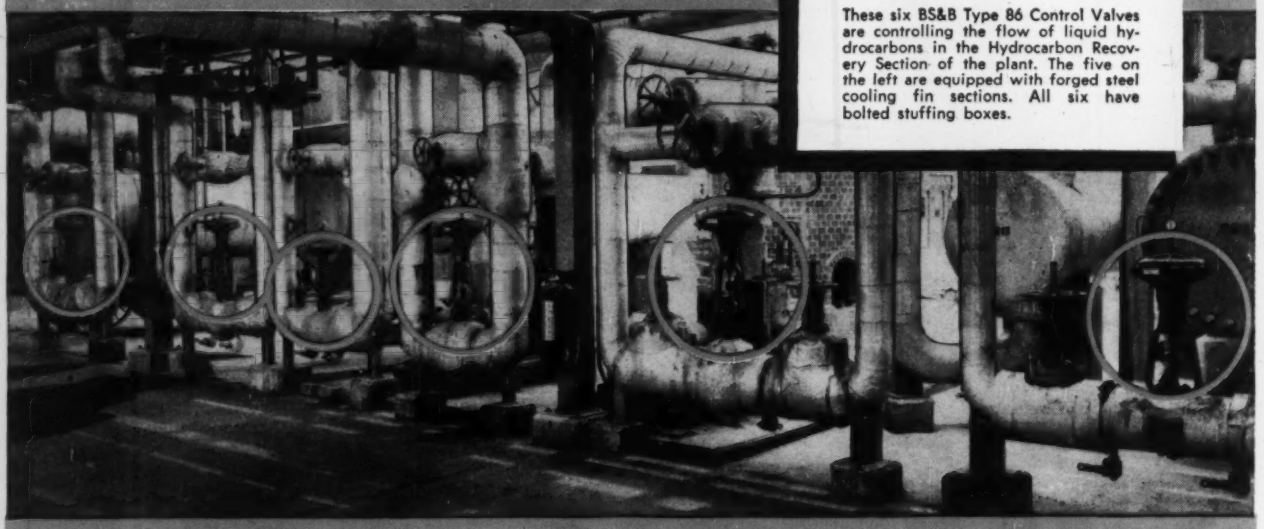
Automation—The way to a society in which labor is necessary not for the physical needs of the body, but for the creative needs of the soul.

SECOND INTERNATIONAL AUTOMATION EXPOSITION

CHICAGO NAVY PIER
November 14-17, 1955

Vol. 28, No. 10
OCTOBER 1955

Where *Dependability* Counts Most...



These six BS&B Type 86 Control Valves are controlling the flow of liquid hydrocarbons in the Hydrocarbon Recovery Section of the plant. The five on the left are equipped with forged steel cooling fin sections. All six have bolted stuffing boxes.

BS&B Automatic Controls Get The Job!

One of the largest petro-chemical plants in the world is that of the National Petro-Chemicals Corporation at Tuscola, Illinois. This $50,000,000 plant extracts the heavier hydrocarbons from natural gas and converts them into fuels and chemicals used in the manufacture of plastics, synthetic fibers, fertilizers, detergents and dozens of other useful products.

This plant is largely automatic, thanks in large measure to numerous BS&B Pressure Control Pilots and Liquid Level Control Pilots—and to *more than 200* BS&B Automatic Control Valves in plant service!

Valves range in size from ¾" to 8", many supplied with special body materials. Body types range from screwed globe cast iron valves to 600# ring type joint, flanged globe steel valves. Some were supplied with Haveg Bodies.

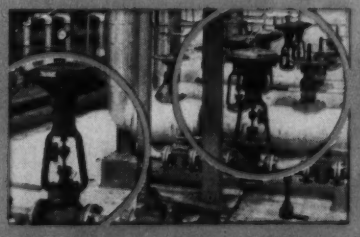
Valve trim included such materials as stainless steel and Hastelloy "B". Several valves in strategic plant locations were furnished with our Type Y Side Handwheels for emergency operation in the event of an operating medium failure. Some, destined for high temperature operation, were equipped with finned cooling sections. Many were furnished with valve positioners, either yoke mounted or mounted in the diaphragm case.

But however specialized the application, each BS&B Control was selected for the job because of its *dependability*... so vital to the successful operation of so complex a plant!

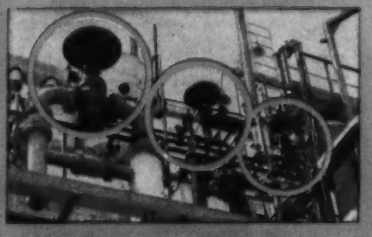
Next time you have a project in the planning stage, why not discuss the controls aspect of it in *strictest confidence* with our representative to be sure you get the *very best* controls for the job to be done?

For Better Regulation of Pressures, Temperatures, Liquid Levels or Flow, Equip Your Process With BS&B AUTOMATIC CONTROLS and SAFETY HEADS!

EFFICIENCY
OVER 60 YEARS
BS&B
RELIABILITY
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP



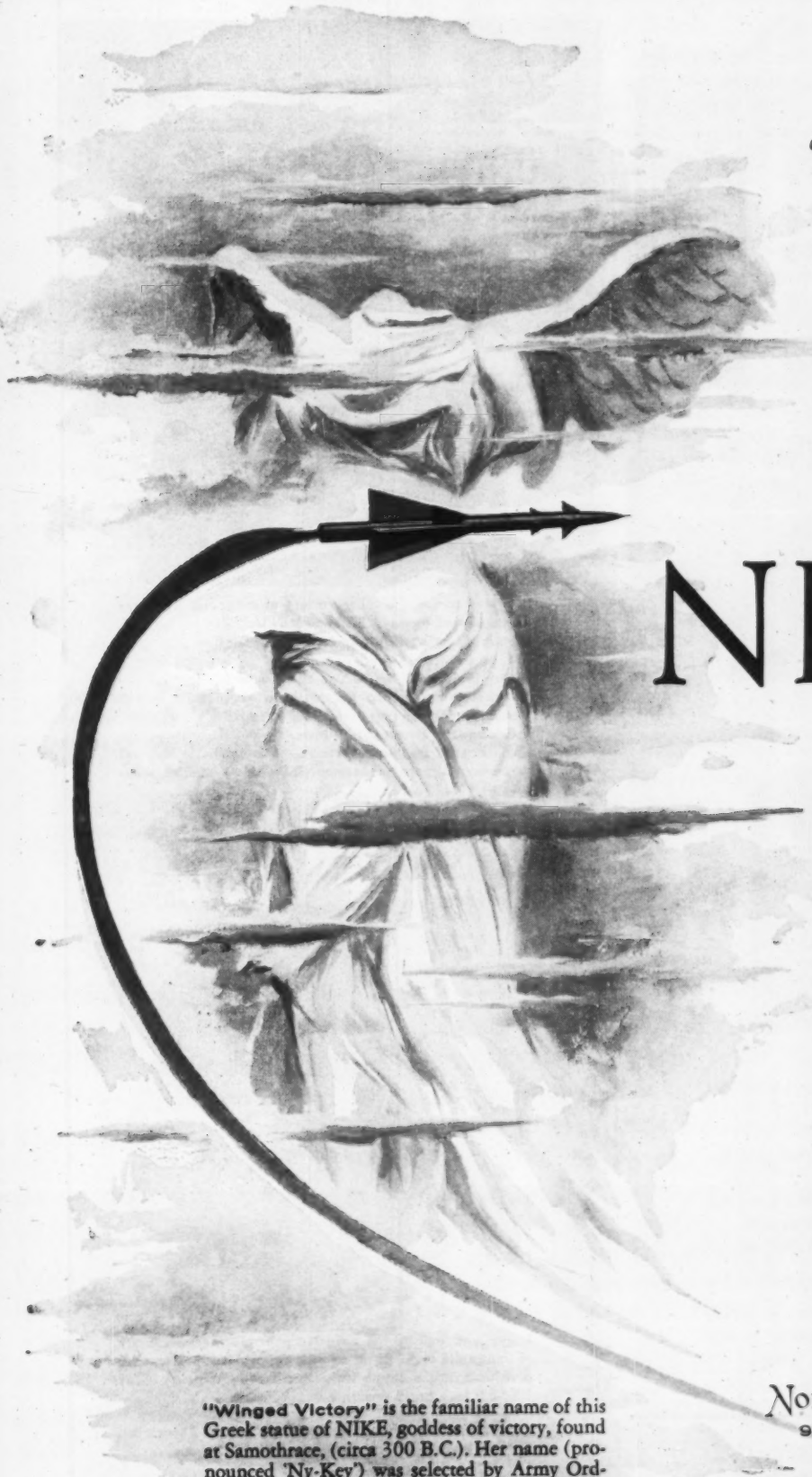
These six Type 86's, also with bolted stuffing boxes, are controlling the flow of fuel gas to the still heater in the Hydrocarbon Recovery Section of the plant.



These three BS&B Control Valves are on ethylene service in the Ethylene Section of the plant. On the left is a BS&B Type 73 DC Pressure Balanced Control Valve. In the center is a Type 86 with Finned Cooling Section and Jumbo Diaphragm. On the right is a Standard Type 86 with Large Topworks.

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 4-V10
7500 East 12th Street Kansas City 26, Missouri

For more information circle 1 on inquiry card.



"She not only thinks—she even dreams!" These are the words which express the full implication of NIKE, the new guided missile that has a vital part in defense planning. NIKE seeks, locates, and destroys an airplane...another missile... anything that flies. The deadly reliability of her guidance system depends in part on *SYNCHROS* which translate electrical impulses into positioning data.

NIKE

Based on their experience, research facilities, and performance in volume production, the Precision Components Division of Norden-Ketay was chosen by Western Electric Company, prime contractor, to develop and produce special *SYNCHROS* for NIKE. Norden-Ketay also serves most of the other leaders in automatic control.

Look to Norden-Ketay for

SYNCHROS • SERVO MOTORS • DIGITAL CONVERTERS • RATE GENERATORS • RESOLVERS • MAGNETIC AMPLIFIERS • GEAR TRAINS • POTENTIOMETERS • NAVIGATIONAL SYSTEMS • FIRE CONTROL SYSTEMS • SERVO MECHANISMS • AIRBORNE INSTRUMENTS • BOMB DIRECTOR SYSTEMS • AIR DATA INSTRUMENTS • COMMUNICATION EQUIPMENT • COMPUTERS • PRESSURE GAUGES •

"Winged Victory" is the familiar name of this Greek statue of NIKE, goddess of victory, found at Samothrace, (circa 300 B.C.). Her name (pronounced 'Ny-Key') was selected by Army Ordnance as most appropriate for the ground-to-air missile developed for them by Bell Telephone Laboratories. Norden-Ketay is proud to have been chosen as an integral part of the team which produced NIKE.

NORDEN-KETAY CORPORATION
99 Park Avenue, New York 16, N. Y.

RESEARCH & DEVELOPMENT LABORATORY:
The Norden Laboratories, White Plains, N. Y.

MANUFACTURING DIVISIONS:
Precision Components Division, New York, N. Y.
Commack, Long Island, N. Y., Hawthorne, California
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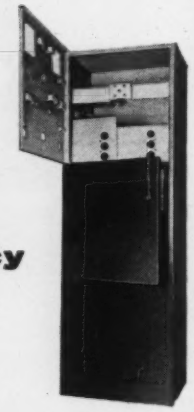
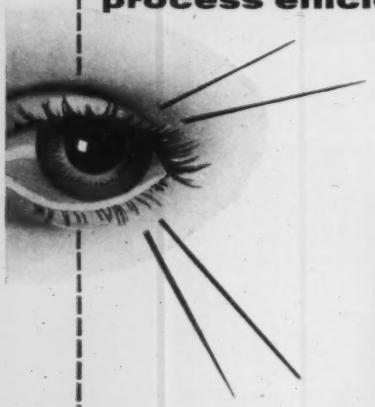
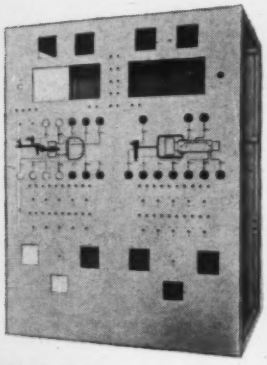
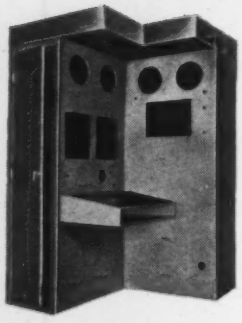
For more information circle **2** on inquiry card.

FALSTROM
"VISIONEERED" panels and control boards help improve process efficiency









Falstrom "visioneered" steel instrument and control boards, graphic panels, consoles, cubicles and cabinets are made exactly to your designs and specifications so as to achieve better functional integration of your instruments, for easier supervision with less fatigue. Falstrom fabrications are made to close tolerances and because of Falstrom's large facilities and modern equipment, no need to sacrifice or compromise on your original specifications and intentions.

Falstrom's "visioneered" construction gives you exactly what you envisage. Put Falstrom "visioneering" to work for you in accurate mountings of any size, in any metal—at low cost.

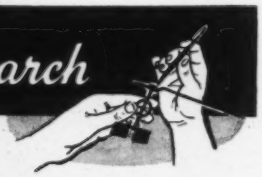
Write for Falstrom catalog of standard panels and control boards 143A or send prints and requirements for prompt estimate.

FALSTROM

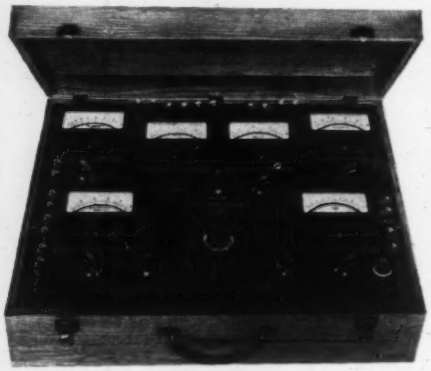
FALSTROM COMPANY
92 Falstrom Court • Passaic, New Jersey

For more information circle **3** on inquiry card.

Sensitive Research



UNIVERSAL MAGNETIC TESTING SET



Designed to make a wide variety of magnetic measurements according to A.S.T.M., such as:
***Core loss testing* using Epstein specimens or standard E and I cores.**
Determination of *B-H curves* and *Hysteresis loops*.
Measurements of *Total Flux* of hard magnets.
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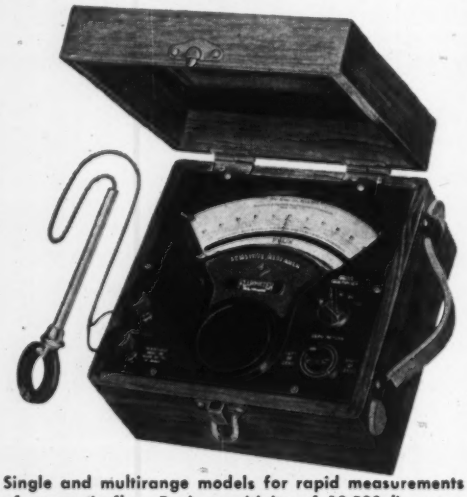
A.C. and D.C. *permeability* tests.
Six precision instruments enable this portable test set to make magnetic measurements with an overall accuracy of 1%.

MULTIRANGE FLUXMETER



Single and multirange models for rapid measurements of magnetic flux. Basic sensitivity of 10,000 lines per division using a single turn search coil. Accuracy .5 of 1%, 5.2 inch hand drawn mirrored scale.

Represented in New England by Yewell Associates. Offices in Bridgeport, Conn. and Waltham, Mass.

Inquiries Invited – Write Dept. IA 5.

SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N. Y.

Symbol of Quality — ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1917

For more information circle **4** on inquiry card.

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COSTS NO MORE THAN ORDINARY OSCILLOGRAPHS

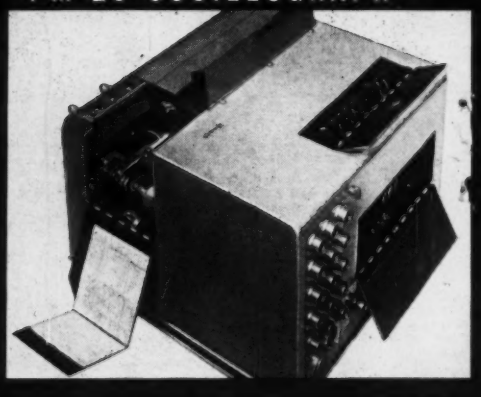
Even though the new General Electric PM-20 general-purpose oscillograph has many features not found on comparable oscillographs, it is priced at only $4,200* net.

A WIDE RANGE of frequencies—from d.c. to 6,000 cps—can be recorded at speeds from 0.8 to 100 inches/sec with the new oscillograph.

AUTOMATIC RECORD NUMBERING, timing lines, trace interruption for identification, and automatic record-length control are a few of the many additional features provided for convenient operation.

*Galvanometers and magnet assembly are not included.

PM-20 OSCILLOGRAPH

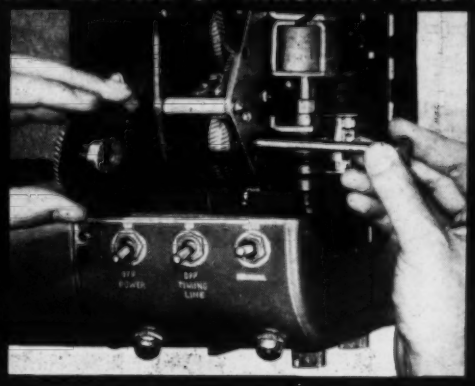


4 **EASY-ACCESS DESIGN** facilitates fast operation and maintenance. Both galvanometer banks and the gear train are

GENERAL ELECTRIC ANNOUNCES . . .

New Industrial Oscillograph with 5 Exclusive Features

FOR DYNAMIC OR STATIC TESTING OF AIRCRAFT AND INDUSTRIAL EQUIPMENT . . .

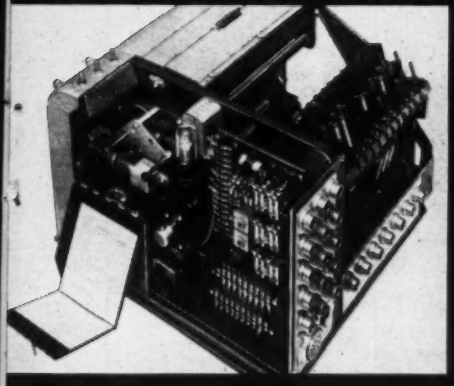


1 **71-GALVANOMETER CAPACITY** in two banks gives versatility in measuring and recording many variables simultaneously.

2 **ONLY 2 IDLER GEARS TO CHANGE** and both are always in use eliminating storage and the chance of loss. No tools are necessary to move the gears.

3 **MAGNETIC SPOOLS** in the record holder simplify loading. The spools automatically position themselves in the record holder.

IS UNIQUELY DESIGNED FOR EASY OPERATION AND MAINTENANCE



GENERAL ELECTRIC COMPANY
SECTION C585-5
SCHENECTADY, N. Y.

Please send me the following bulletin:
PM-20 General-purpose Oscillograph (GEA-6348)

Name .....

Company .....

Street .....

City ..... **Zone** ..... **State** .....

readily accessible through hinged doors in the lightweight aluminum case. The entire cover may be removed by loosening three fasteners.

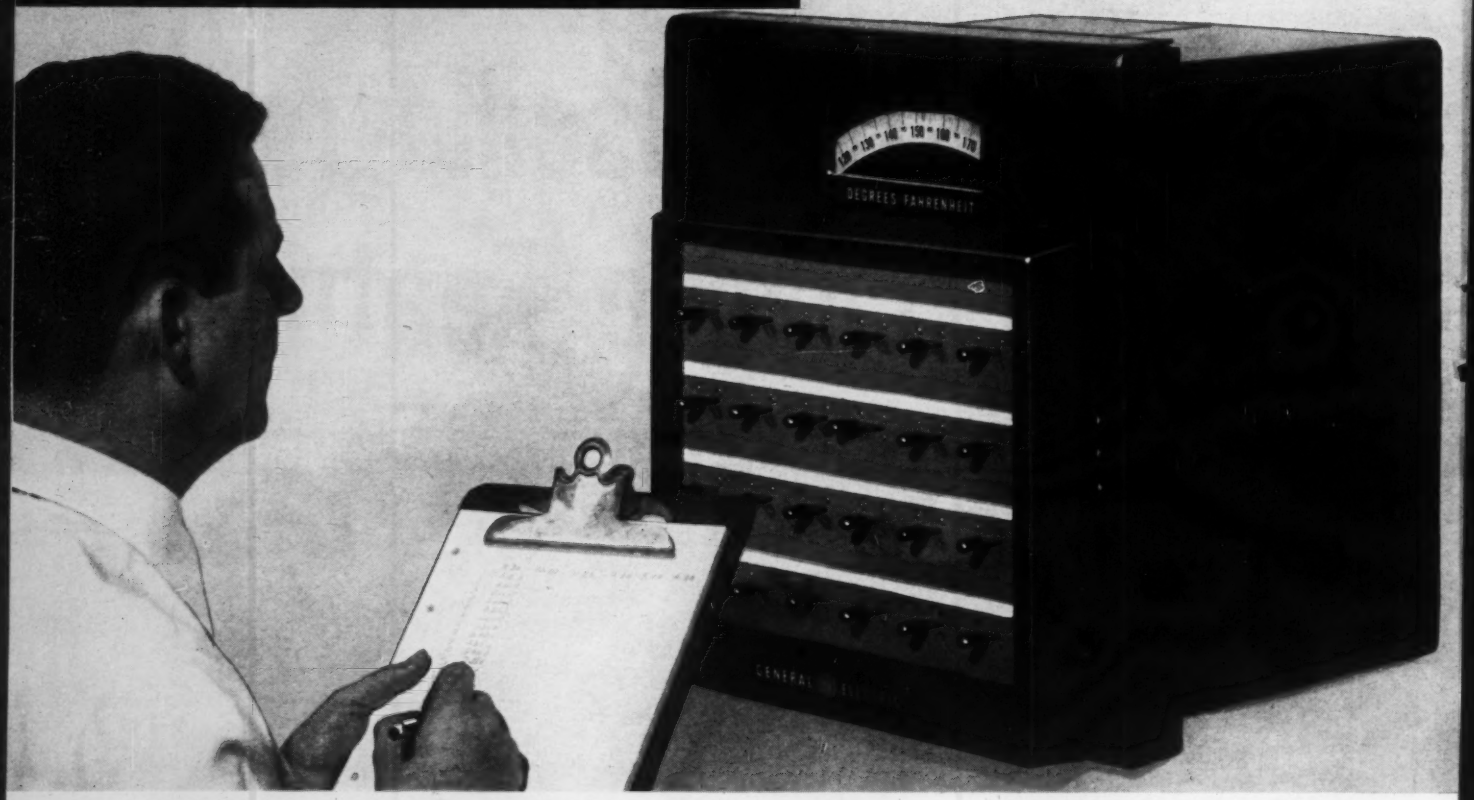
5 **SEPARATE VIEWING LAMP** eliminates adjustments of recording lamp intensity for viewing. Lamps are easily accessible by removing the record holder.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or use the coupon above to request a copy of bulletin GEA-6348.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information circle **5** on inquiry card.



G-E PRECISION INDICATOR is available as a single-point or multiple-point instrument. For multi-point instruments different types of switches are available. The toggle type, pictured above, is either locking or non-locking, according to specifications. The push-button type remains in a depressed position until another button is pushed. The large easy-to-read scale supplies quick temperature readings for accurate records and makes logging a simple job for the operator. For further information contact your nearest G-E representative or send in coupon at the right.

USE G-E PYROMETERS FOR ACCURATE CONTROL

General Electric Pyrometers Give Dependable Protection

TYPE HP-3 PYROMETER, a two-position controller, has positive control action, initiated by 0.1 percent in full scale movement of instrument pointer. This gives accurate readings from easy-to-read 7-inch scale. Units are available for flush or surface mounting. Indicator, controller, and protector units are plug-in type, permitting easy servicing.

For more information circle **6** on inquiry card.

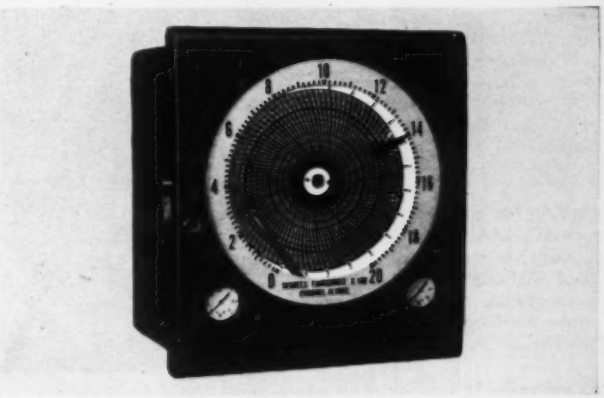
New G-E Precision Indicator Makes Temperature Checks Quick and Easy

New G-E Instrument Gives Finger-tip Scanning of up to 48 Process Temperatures in Helping You Maintain Accurate Product Control

General Electric's new precision indicator scans, by manual switching, from 1 to 48 process temperatures on multi-installations of thermocouples or resistance-bulb circuits. The new G-E potentiometer features a wide temperature range scale and is a high-accuracy, null-balancing instrument.

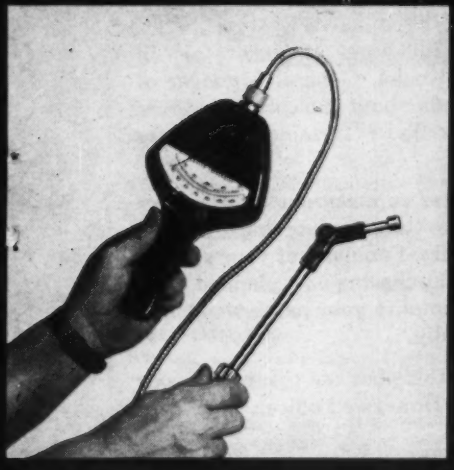
NEW G-E INDICATOR assures you of having less maintenance by eliminating conventionally used dry cells, slidewire and sliding contacts. This excludes such time-consuming jobs as replacing dry cells, or cleaning moving contacts.

THE MAGNETIC STANDARD provides truly continuous standardization through a revolutionary measurement-circuit design, which incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control during standardization periods can never be experienced with constantly balancing G-E system.



G-E RECORDING CONTROLLER has same measurement-circuit design as precision indicator. Long term accuracy and precision of measurement are assured, and you get continuous dependable control with truly continuous standardization.

G-E HAND PYROMETER DESIGNED FOR WIDE USE



GENERAL ELECTRIC COMPANY
SECTION D587-1
SCHENECTADY 5, NEW YORK

Please send me a copy of the interesting and colorful bulletins checked below:

- ☐ GEA-6020 Hand Pyrometer
- ☐ GEC-713 Thermocouple and Accessories
- ☐ GEC-1311 Type Precision Indicator
- ☐ GED-2100 New Recording Controller

Name.....
Company.....
Street.....
City..... Zone.... State.....

DUAL-RANGE General Electric hand pyrometer is designed for more flexible and inexpensive measurement of gas, surface and molten-metal temperatures.

EASY-TO-USE hand pyrometer accurately indicates temperature of precision castings. The instrument is light in weight with a non-slip, bayonet-grip handle.

Progress Is Our Most Important Product

GENERAL ELECTRIC

All-weather Brown thermocouple head saves time and trouble

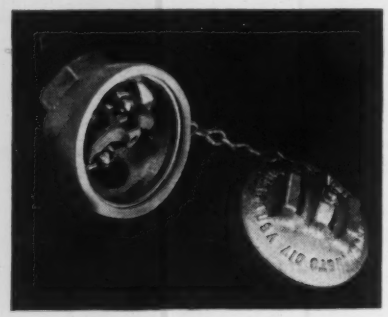
Like the other function-designed supplies in the Brown pyrometer accessories line, the screw type thermocouple head is engineered for the top in utility and convenience.

It can't freeze or rust. Threads are cut on the *inside* of the head, where they are protected from external moisture and corrosive atmospheres. The threads are plated and enameled *after* machining . . . to assure that a complete protective finish covers the thread surfaces. The entire head is hot dip galvanized and enameled for maximum weathering properties. A heat and moisture resistant gasket seals the thermocouple and extension wire connections from the damaging effects of outside atmospheres.

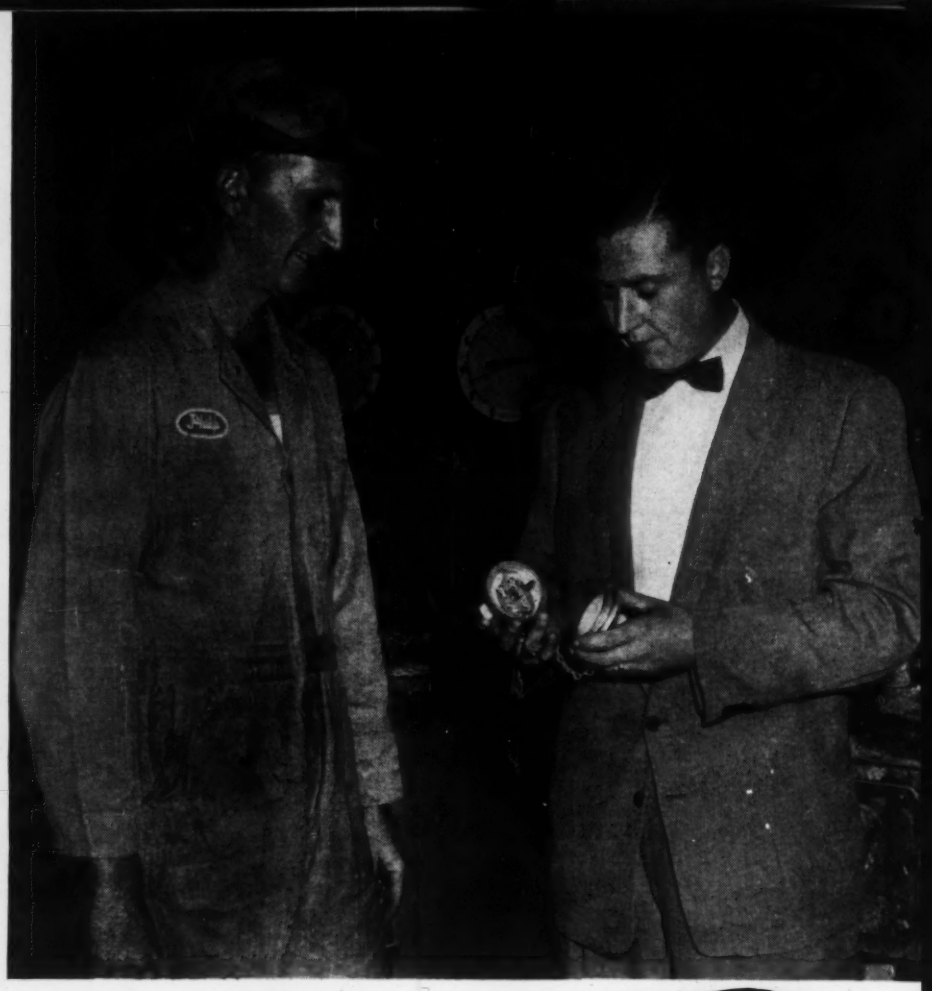
It's built for convenience. You need no special tools. The slotted head makes it easy to remove or to tighten the head without using a wrench. A chain connects the head to the base . . . prevents waste of time for recovering a head that drops off.

It's versatile. It can accommodate terminal blocks for either single or duplex thermocouples or resistance thermometers.

It uses standard pipe thread outlets, and is interchangeable with other heads.



The Brown screw type thermocouple head is recommended for outdoor service, and for applications where atmospheres are corrosive. Its general versatility, however, makes it useful in so many other installations that you should consider it for any spot where thermocouple connections may give trouble. Your local HSM will be glad to look over the requirements of your specific location, and to help you choose the type of thermocouple head that best fits the job.



Here's why it pays to know your HSM

HONEYWELL SUPPLIES MAN

HOWARD PALMER, *at right*, HSM (Honeywell Supplies Man) in the Philadelphia area, tells Philip Keidel, General Manager of Robert Wooler, Dresher, Pennsylvania about the corrosion-proof construction of Brown Screw Cover Type Terminal Heads for thermocouples.

The HSM Plan for buying pyrometer supplies not only assures you of getting the best in quality from the complete line of Brown accessories . . . but, through personalized analysis of your specific problems, it places all your supplies purchasing on a planned basis that can cut your inventory needs, simplify your paper work, and often reduce overall costs substantially.

Ask your local HSM to discuss how this plan can operate in your own plant. Call him at your nearby Honeywell office . . . as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for the booklet, "The HSM Plan"... and for Pyrometer Supplies Buyers' Guide No. 100-6.**

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

For more information circle 7 on inquiry card.

Here's the Relay for today's high speed devices

Highly Sensitive
No Contact Bounce
Billions of Operations

THE CLARE TYPE T
High Frequency
Impulse relay

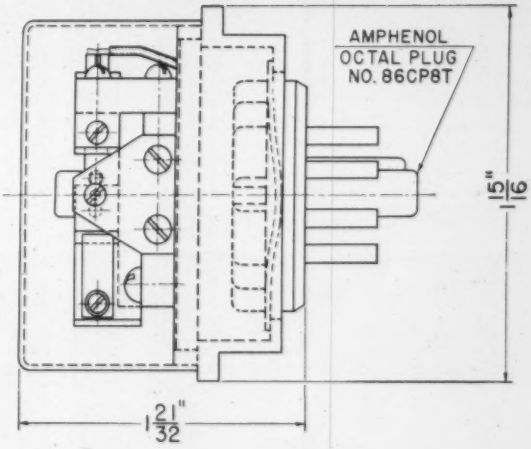
• Shown above with dust-tight cover removed (left) ready for mounting.

• Announcement of the CLARE Type T High Frequency Relay two years ago set off such a deluge of inquiries for samples and information that it is only just now that production facilities permit us to mention it again.

Originally designed for use in an analog computer, this relay is ideal for designs which call for a highly sensitive relay completely free from contact bounce and capable of billions of operations at extremely high speeds.

Pull-in time of this relay, for instance, is 120 microseconds. With dropout time of 100 microseconds, the relay follows up to 2500 cycles per second; aperiodic to 1000 cycles per second.

Manufacture of the CLARE Type T Relay, with its high speed, no bounce and other unusual characteristics, necessitated the development of entirely new techniques. It is built to extremely close tolerances, with a high degree of precision and fabricated under conditions of utmost cleanliness.



SPECIFICATIONS

MECHANICAL

Size: 1-15/16 in. dia. x 2-3/16 in. overall. Weight: 5 oz.

Mounting: Equipped with plug, to fit standard 8-pin octal socket.

Cover: Removable dust-tight cover.

Contacts:
- **Type:** Form A (s.p.s.t., normally open)
- **Material:** Platinum-iridium
- **Gap:** 0.0005 inch
- **Pressure:** 30 grams, min. (Coil energized with 50 ampere-turns)

Coil:
- **Type:** Single winding, bobbin-wound.
- **Wire:** Heavy formex.

ELECTRICAL

Operate Ampere-Turns: 8 to 20.

Release Ampere-Turns: 1 to 4 less than operate ampere-turns.

Nominal Ampere-Turns for High-Speed Operation: 16 to 40.

Speed of Operation: will follow 2500 cycles per second; aperiodic to 1000 cycles per second.

Operate Time: 100 to 180 microseconds.

Release Time: 60 to 120 microseconds.

Contact Bounce: None.

Contact Current Rating: 0.05 amp., max.

Contact Voltage Rating: 150 V., max.

Dielectric Strength: 500 V., rms.

Coil Resistance: up to 600 ohms.

Life Expectancy: 5 x 10^9 operations (determined by contact load).

TYPICAL CHARACTERISTICS

Coil Resistance: 135 ohms.

Coil Inductance: .35 Hy.

Operate Current: 10 to 12 ma.

Release Current: 8 to 10 ma.

Nominal Current: 40 ma., steady state; 20 ma., average.

Operate Time: 130 microseconds.

Release Time: 100 microseconds.

Energizing Circuit: Coil in plate circuit of vacuum tube with 300 volt plate supply.

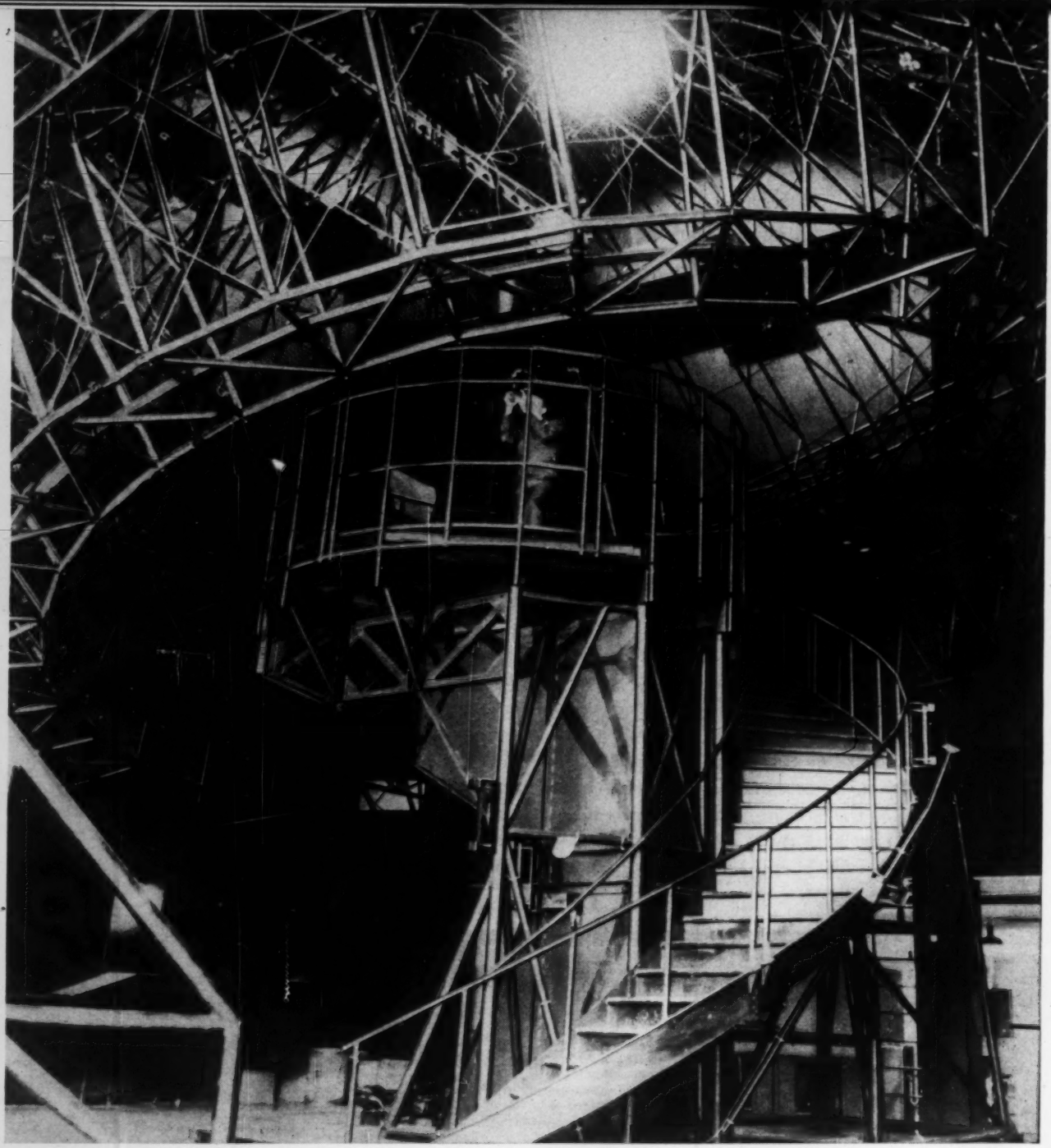
For full information on the CLARE Type T Relay —or for consultation on any relay problem—see your nearest CLARE Sales Engineer or write C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Send for Clare Bulletin Number 117

FIRST IN THE INDUSTRIAL FIELD

CLARE RELAYS

For more information circle **8** on inquiry card.



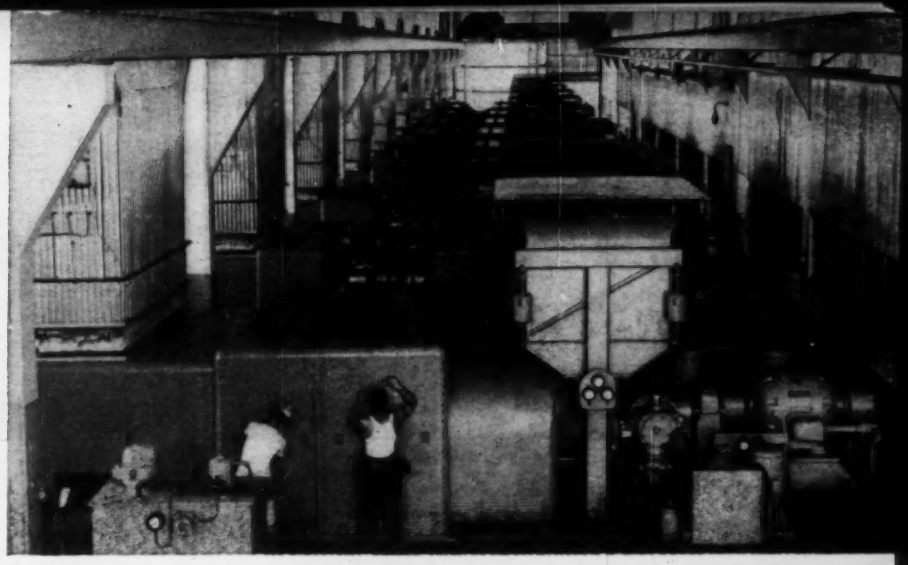
CELESTIAL NAVIGATION—Link Aviation's high-speed, high altitude celestial navigation trainer; only such trainer capable of simulating trans-Polar flight. Trains navigators in techniques of guiding planes by the stars.

Vital Controls

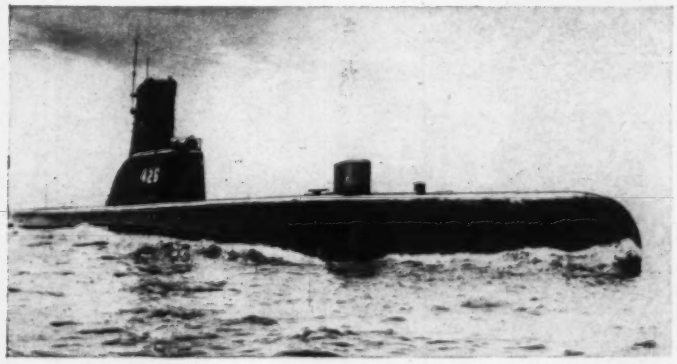
The controls on the world's fastest submarine; the most advanced airborne navigation system known to exist; other similarly advanced military systems and equally advanced industrial equipment and control systems are outstanding examples of the work of the producing companies of General Precision Equipment Corporation. More than a dozen major industries are served by instrumentation and systems designed, developed and produced by GPE Companies.

Ten of the companies in the GPE Group — notably Askania, Kearfott, Librascope and Link Aviation—devote substantial resources to the development and manufacture of instruments, servos and controls. These are used in equipment and systems developed by these companies

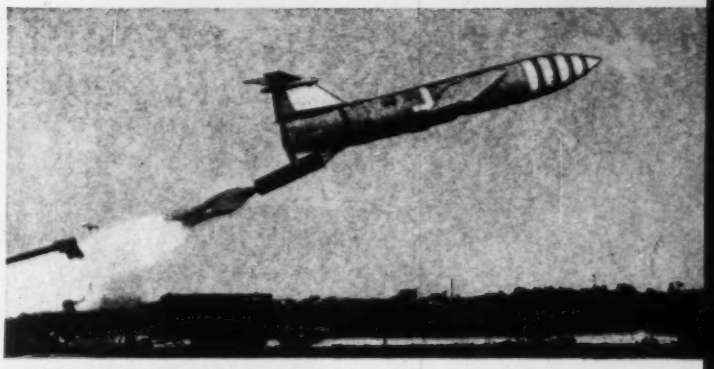
For more information circle 9 on inquiry card.



PROCESS CONTROL—Askania controls regulate speed of the ten turbines which develop compression to maintain gas suction pressure in Creole Petroleum Corporation's giant, pile-supported oil drilling operation on Lake Maracaibo, Venezuela.



SUBMARINE OPERATION – Controls developed and produced by Askania Regulator Company are utilized to govern operation of U. S. Navy's modern Guppy type submarines.



MISSILE GUIDANCE—One of the many guided missiles equipped with Kearfott basic gyro reference systems, the B-61 Matador—U. S. Air Force's first successful ground-to-ground tactical weapon.

GPE

CAPACITIES

● Manufacturing
●● Manufacturing and product development
●●● Manufacturing, product development and research
□●● Pilot manufacturing, product development and research

	KEARFOTT COMPANY, INC.	INTERNATIONAL PROJECTOR CORPORATION	BUDWORTH MARINE DIVISION	GENERAL PRECISION LABORATORY INCORPORATED	THE GRISCOM-RUSSELL COMPANY	LINK AVIATION, INC.	THE HERTNER ELECTRIC COMPANY	THE STRONG ELECTRIC CORPORATION	J. E. McAULEY MFG. CO.	ASKANIA REGULATOR COMPANY	AMPRO CORPORATION	LIBRASCOPE, INCORPORATED
PRECISION MECHANICS, OPTICAL DEVICES, CERAMICS	●●●	●●	●●	□●●	●●	●●●	●●	●●●	●●	●●	●●	●●●
ELECTRICAL EQUIPMENT and COMPONENTS	●●●	●	●			●●●	●●●	●●	●	●●	●	●●●
ELECTRONICS	●●●	●●	●●●	●●●		●●●	●	●●		●●●	●●	●●●
HYDRAULICS, LIQUIDS PROCESSING, HEAT EXCHANGE		●●			●●●					●●●		
TELEVISION Studio, Theatre, Educational, Business, Industrial	●	●		●●●		●				●		
INSTRUMENTS, SERVOS, CONTROLS Hydraulic, Pneumatic, Magnetic, Electronic	●●●	●	●●	□●●		●●●	●●	●●		●●●	●	●●●
AIRCRAFT and MISSILE GUIDANCE, CONTROL, SIMULATION	●●●	●		●●●		●●●	●			●●	●	●●●
AUTOMATIC COMPUTERS and COMPONENTS	●●●	●	●	□●●		●●●				●●●		●●●
RADAR, MICROWAVE, ULTRASONICS	●●●	●	●●	●●●		●●		●		●		
MOTION PICTURE and AUDIO EQUIPMENT		●●●		□●●			●●	●●●	●●●		●●●	
NUCLEAR POWER COMPONENTS and CONTROLS	●●●				●●					●●		●●●
SYSTEMS ENGINEERING Aeronautical, Naval, Industrial	●●●			●●●	●●●	●●●				●●●		●●●

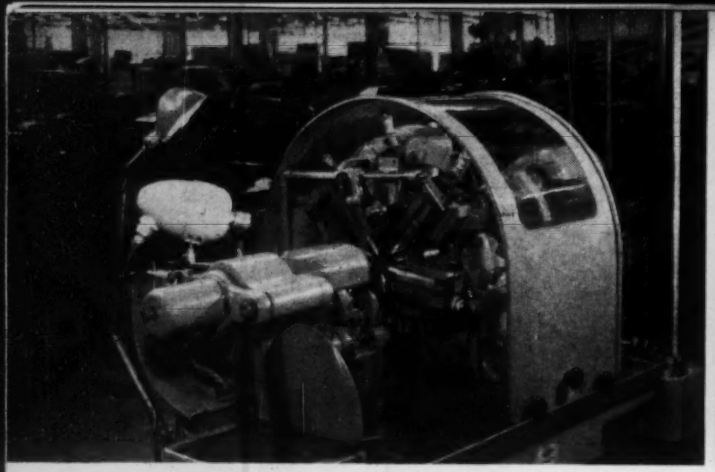
themselves, as well as in systems and equipment developed and produced by other manufacturers of advanced technological equipment.

All GPE Producing Companies work in the advanced areas of highly specialized fields and are engaged in the design, development, manufacture and sale of equipment which is closely related from a technical point of view. It is all precision equipment; it derives from similar fields of technical competence; it saves labor, increases productivity or achieves results which cannot be achieved with even limited use of on-the-spot manpower. The chart here shows the specialized fields in which the key GPE Producing Companies work.

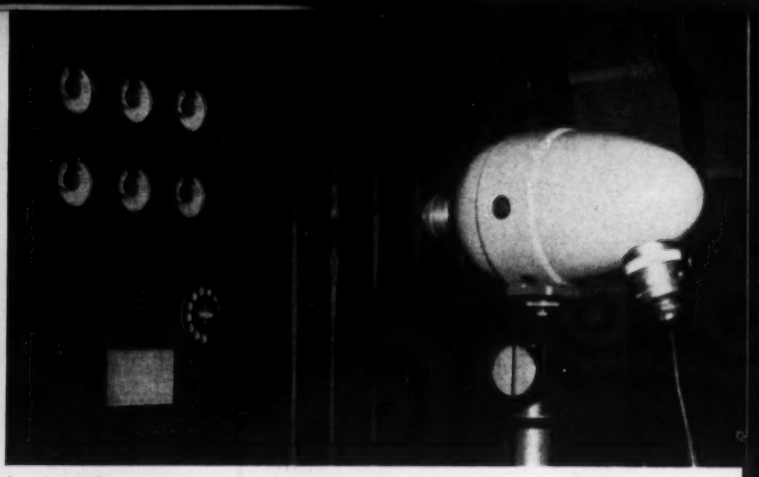
In addition to specialization in its particular products and fields of technical competence, each of these companies has at its command, as required, the facilities and specialized techniques of the other GPE Companies in their respective fields. Interrelation of their resources is achieved through GPE's basic operating policy, GPE Coordinated Precision Technology. In all areas in which GPE Companies work, this coordination has been responsible for a wide variety of precision equipment of superior design and performance, embodying new, advanced principles.

A brochure relative to the work of the GPE Companies and GPE Coordinated Precision Technology is available. Address your request, or specific inquiries, to: GENERAL PRECISION EQUIPMENT CORPORATION – 92 Gold Street, New York 38, N. Y.

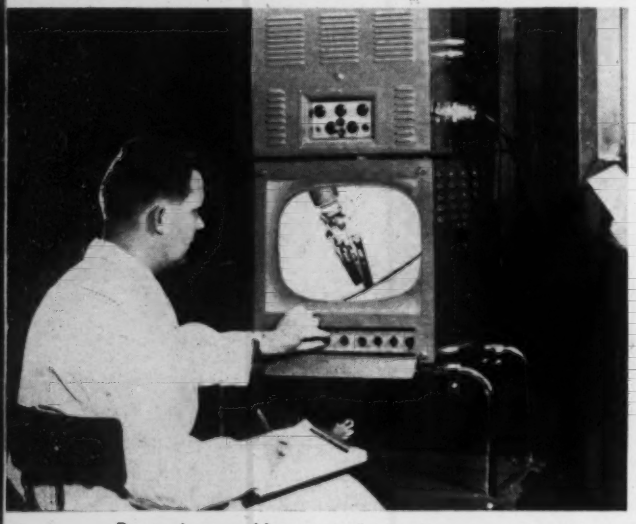
For more information circle 9 on inquiry card.



Watching machines is a job for the GPL TV camera. Above, the GPL camera mounted to face a screw-making machine instantly reports anything needing attention to the operator, increasing the number of machines he can tend efficiently.



In automation, whenever there are dials to be checked, the GPL TV camera can report to a central point. Motorized on rails or to swing around, the camera scans a whole bank of dials, sweeps an area. Equally useful in non-automatized production.



Danger is no problem. The GPL industrial TV camera can look into the face of danger and never blink. Above it reports to the operator a hazardous process taking place inside a test cell.

Wherever security control is a problem, strategically placed GPL TV cameras multiply the eyes of your guards. Here a single camera keeps watch over vital military equipment. Similarly, GPL TV cameras can guard the aisles of warehouses, restricted areas, exposed loading platforms.

Control Problems Solved by Seeing

GPL industrial television opens up new possibilities in control by providing instantaneous visual information on what's happening.

Good control is based on good information. And for many purposes no information can match seeing what is happening right on the spot. You can do just this, anywhere, anytime, with the industrial and institutional television equipment designed and made by General Precision Laboratory Incorporated, and known as GPL ii-TV.*

No spot is too far away, too dangerous, too cramped for GPL ii-TV. Unattended, the camera permits observers to see around corners, through walls, across thousands of miles, within the whirling heart of a machine. It can bring many scattered events to a single observer and, with GPL TV projectors, a single event to many scattered audiences.

With this new tool you can solve many kinds of control problems. You can use GPL industrial television to monitor remote machines. You can study a wing tip five miles up, or watch a grapnel grope along the ocean floor. You can follow and control a dangerous process, step by step, safe from fumes or radiation. You can control access to restricted areas, check signatures against a master file.

In fact, you can use GPL industrial television for anything that requires instant communication of visual information. You can improve skills and techniques of workers in scattered plants with visual demonstrations. You can run face-to-face conferences of far-flung personnel.

A GPL Industrial and Institutional Television System can do all these things for you—and many others—with high efficiency and low cost. Here's why:

- It is high-sensitivity, quality equipment. Behind it lies the long experience of General Precision Laboratory in building the finest in broadcast television. GPL equipment is used by 90 percent of all studios equipped for video recording; GPL cameras and controls are found in many of the finest broadcast TV installations.
- Military TV equipment must be really rugged—and GPL has been building it for years. Now GPL has designed your industrial TV system with high-strength elements and simple design that stand the gaff. Special housings protect the camera from weather, heat, shock, explosions.
- GPL's compact industrial camera is bullet-shaped to squeeze in almost anywhere. Only 2" larger in diameter than a baseball, it weighs 5 lbs. The 26-lb. control cabinet, the size of an overnight case, can be far from the camera.
- GPL's industrial camera is unique in its ability to obtain a good picture at very low light levels. With its Vidicon pick-up tube it can work under highly adverse conditions.
- GPL enables you to multiply your audience with a TV projection system for industrial use. It is made like the famed GPL theatre projectors used all over the country; mounted on rollers for complete mobility.

For more information on what GPL ii-TV can do for you—and suggestions on your special problems—write to: GENERAL PRECISION LABORATORY INCORPORATED, Pleasantville, N. Y. (A subsidiary of General Precision Equipment Corporation.)

* Trade-mark

Visit us at Booth 439 at the Automation Show

For more information circle 10 on inquiry card.

now FOR DC OR RESISTANCE INPUT

MODEL 200-A uses an input of 10,000 ohm resistance potentiometers as an input transducer providing 10 to 1 scale expansion and origin positioning. Available standard digital input accessories are essentially inputs of this type. Any resistance potentiometer will provide an analog input for this configuration.

MODEL 200-B, used for D.C. signal input, has full scale sensitivities of 5 millivolts and an input impedance of 1,000 megohms. Utilizing standard reference cells, this model provides drift-free operation. Available external reference voltages may be substituted. A plug connection is provided to facilitate the quick interchangeability of input sections.

now FOR SIMPLIFIED OPERATION

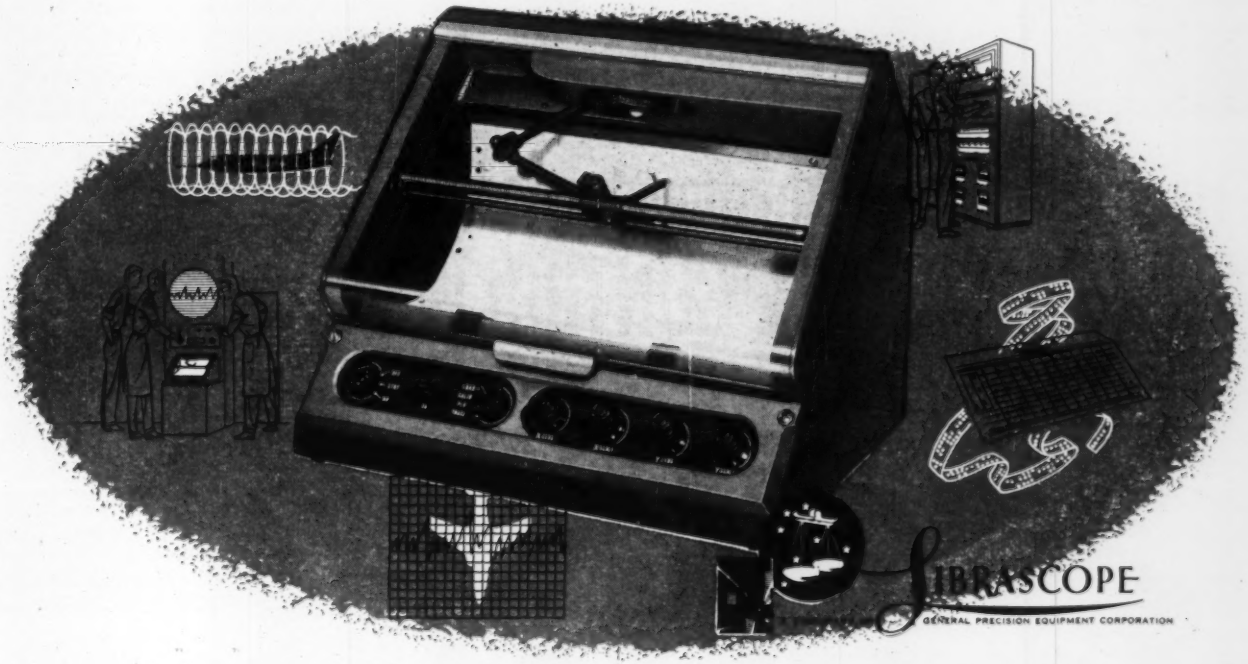
Precision Vernier Dials provide an accurate method for obtaining fine adjustment during operation. Optional point plot or continuous line plotting is a feature of both models. Selection is by front panel manual control. A new, simplified pen of one-piece design-used for point or continuous plotting—eliminates bottles and tubes, permits rapid changing of ink colors. Independent action of the X and Y axis is achieved with Librascope's unique "Floating Gear Train." No cables, tapes or lead screws to cause lost motion, cable stretching or drifting out of alignment. The 120° concave cylindrical plotting surface provides full visibility . . . is completely illuminated.

now FOR WIDER APPLICATION

These fast, dependable general purpose plotters feature 0.1% accuracy, are suited for wide applications where rapid graphic presentation of data is required, such as: laboratory testing, computers, data handling systems, wind tunnel, missile tracking and quality control testing of transistors and other electronic components. Input selection includes Punched Card and Tape Converters, Decimal Keyboards and Binary Converters. Model 200-A can plot from Flexowriter tape in any code or directly from the Tape Punch cables of many digital computers. Subchassis can be supplied to handle time-shared X versus Y plots, or other special circuitry. Write today for details.

LIBRASCOPE X-Y PLOTTER

HIGHEST ACCURACY FOR GRAPHIC DATA HANDLING



Greater input flexibility | For desk or rack mounting

NEW LIBRASCOPE PUNCHED TAPE CONVERTER
Operates from a punched tape reader—Specially designed for Librascope X-Y Plotters—This unit is adaptable to other plotters.

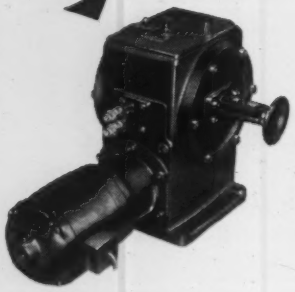
LIBRASCOPE PUNCHED CARD CONVERTER
Converts punched card data to analog form for input to X-Y Plotters. Automatic Position for feeding 50 punched cards per minute.

LIBRASCOPE INCORPORATED • 808 WESTERN AVENUE • GLENDALE, CALIFORNIA

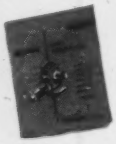
For more information circle 11 on inquiry card.

A portion of the 200 acre scale model of the Mississippi Basin, shows one of the Askania Controls used in this flood control study.

Huge 200 acre experiment needs PRECISE CONTROL!



The Askania Unit Regulator, a completely self-contained automatic control. This versatile unit, one of an extensive line, finds its widest use in applications where measured signals are low level and power requirements at the point of control are moderate.



The Corps of Engineers, U. S. Army uses a 200 acre scale model of the Mississippi Basin in flood control studies that may eventually solve that area's flood control problem. In the studies, six standard Askania Controllers were used to assist in precisely simulating the behavior of one of the world's mightiest river systems.

While flood control may not be your problem, precise, sensitive, and powerful Askania controls may be the solution to your control problems. These units are currently solving problems in the metal, glass, plastic, rubber, textile and paper processing industries. If you have control problems that are boosting your costs or lowering your product quality, investigate these Askania Controllers.

Write for Bulletins 139 and 155.

ASKANIA REGULATOR COMPANY
290 E. Ontario Street, Chicago 11, Illinois
Subsidiary of General Precision Equipment Corp.

For more information circle **12** on inquiry card.

Events . . .

October 23-26

Scientific Apparatus Makers Association Midyear meeting of the Laboratory Apparatus and Optical Sections, The Cavalier Hotel, Virginia Beach, Va. For information write Jim Irving, SAMA, 20 N. Wacker Dr., Chicago 6, Ill.

October 24-25

First Annual Technical Meeting of the Professional Group on Electron Devices of the I.R.E., will be held at The Shoreham Hotel, Washington, D. C.

October 27-28

Eleventh Annual Meeting of National Conference on Industrial Hydraulics, LaSalle Hotel, Chicago, Ill., will feature a Computer Session on Thursday morning, the 27th. For information contact R. J. King, c/o Technology Center, 3300 S. Federal, Chicago 16, Ill.

October 28-29

1955 Philadelphia ISA Section Symposium "Automatic Control Loops—Electronic or Pneumatic?", at the Penn Sherwood Hotel, Phila., Pa. For information write c/o R. F. Eisele, Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.

October 31-November 1

International Conference on Scientific Basis of Applied Solar Energy, University of Arizona, Tuscon, Arizona as a prelude to the World Symposium on Applied Solar Energy to be held in Phoenix, Nov. 2-4. For information contact Symposium Headquarters, Suite 204, Mayer-Heard Bldg., Phoenix, Arizona.

November 1-5

SRI, Association for Applied Solar Energy and University of Arizona World Symposium on Applied Solar Energy, Westward-Ho, Phoenix, Arizona. For information write Public Relations Dept., Stanford Research Institute, Stanford, Calif.

November 3-4

Eighth Annual Electronics Conference sponsored by the Kansas City Sec. IRE, Town House, Kansas City, Kan. For information write P. O. Box 391, Kansas City 41, Missouri.

November 3-4

Fourth Annual Louisiana Polytechnic Institute Instruments Conference, Ruston, Louisiana. For information write School of Engineering.

November 7-9

Eastern Joint Computer Conference and Exhibition sponsored by AIEE, IRE and ACM, Hotel Statler, Boston, Mass. For information write Box 223, Boston 1, Mass.

For other computer Events see page 1715.

INSTRUMENTS and AUTOMATION

November 9-11

Nineteenth Annual Time and Motion Study and Management Clinic, Sherman Hotel, Chicago, Ill. For information write Industrial Management Society, 35 E. Wacker Dr., Chicago 1, Ill.

November 13-18

American Society of Mechanical Engineers' 75th Annual Meeting. Hotel Congress, Chicago, Ill.

November 14-17

Second International Automation Exposition will be held at Chicago's Navy Pier. For information write The Second International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

November 14-16

Eighth Annual Conference on Electrical Techniques in Medicine and Biology, sponsored by American Institute of Electrical Engineers, Institute of Radio Engineers and Instrument Society of America, Shoreham Hotel, Washington, D. C.

November 16-18

Society for Experimental Stress Analysis meeting and exhibit, Hotel Sheraton, Chicago, Ill. For information write J. J. McDonald, Consolidated Engineering Corp., 919 N. Michigan Ave., Chicago, Ill.

November 17-18

Tenth Mid-West Conference of American Society for Quality Control, Schroeder Hotel, Milwaukee, Wis. For information contact R. H. Byrnes, 3402-A N. Humbolt Ave., Milwaukee, Wisconsin.

November 28-30

Professional Group on Instrumentation, Atlanta Sec. of I.R.E. Instrumentation Conference, Biltmore Hotel, Atlanta, Ga. For information contact D. L. Finn, School of Electrical Engineering, Georgia Institute of Technology, Atlanta, Ga.

January 9-10

Second National Symposium on Reliability and Quality Control in Electronics, Hotel Statler, Washington, D. C. For information contact V. Wouk, Beta Electric Corp., 333 E. 103rd St., New York 29, N. Y.

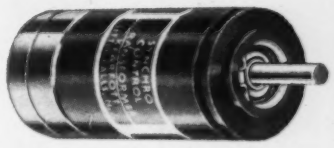
January 19-21

Dallas-Fort Worth Chapter of IRE Professional Group on Electronic Computers National Simulation Conference, Dallas, Texas. For information contact J. R. Forester, 2104 Huntington, Arlington, Texas.

PRECISION COMPONENTS in Production

(shown ¼ size)

GYROS—3 Gyro Platforms, Floated Rate Integrating Gyros, Vertical, Free, Directional, Rate Gyros and Gyro operated Rate Switches—compact, lightweight, hermetically sealed.



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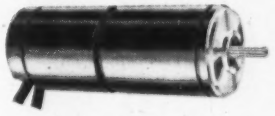
SYNCHROS—Transmitters, Control Transformers, Resolvers, Repeaters, and Differentials in Bu Ord Sizes 15, 11 and 8. High accuracy and environmental resistance.



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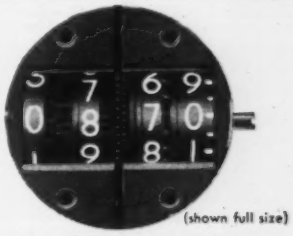
SERVO MOTORS—High torque, low inertia Servo Motors, Servo Motor-Generators, Inertial and Viscous damped Servo Motors ¾" to 1¾" Diameter.



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MECHANICAL DEVICES

Counters, Electro-Mechanical Computers, Hermetic Rotary Seals, Aircraft Instruments and High Temperature Resistant, Chemically Inert, Machinable Ceramics.

(shown ¼ size)

ELECTRONICS—Miniature and subminiature Servo Amplifiers and Magnetic Amplifiers "potted" for convenience of installation and long life.

SYSTEMS

Aircraft Navigational Systems
Industrial Servo Systems
Servo Analog-to-Digital, Digital-to-Analog Converters
Electro-Hydraulic Servo Systems

Send For Technical Data Sheets

Bulletin giving physical and technical data on the various Kearfott Products will be sent on request. The Kearfott organization is available to assist in the development and manufacture of other precision components you may require.

Kearfott

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

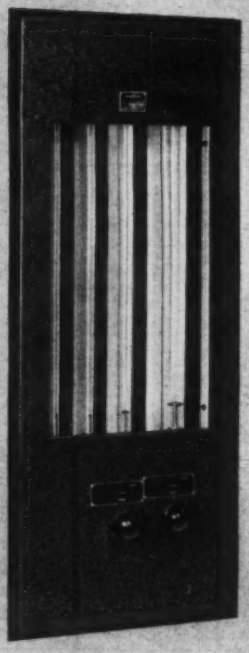
For more information circle **13** on inquiry card.

Holds No Terror

TYPE II VISCOMETER

A new laboratory-field instrument, using advanced flow system design, which quickly indicates kinematic viscosity of fuels, oils, weak acids and other base solutions. Two ranges available: .5 to 5.0 and 3.0 to 30 centistokes. Readability: within 1%. Portable or panel mounted.

COX INSTRUMENTS
prove this day-in-and-out
IN THE LABORATORY . .
ON PRODUCTION LINES



Forty-three years ago, Commercial Research Laboratories produced the *first* precision Cox instruments — far advanced for their day. The name Cox has since become synonymous with accuracy and reliability wherever testing devices are used. So much so, in fact, that scores of aircraft, automotive, and hydraulic equipment manufacturers — here and abroad — have made a common practice of *calling in CRL first* — for expert advice in the design, development and manufacture of *any* hydraulic or air flow measuring device, large or small.

If your own requirements call for the smallest production-model flowmeter, or the most intricate, complete test stand — call in CRL first. Save time—and get dependability *plus* accuracy.

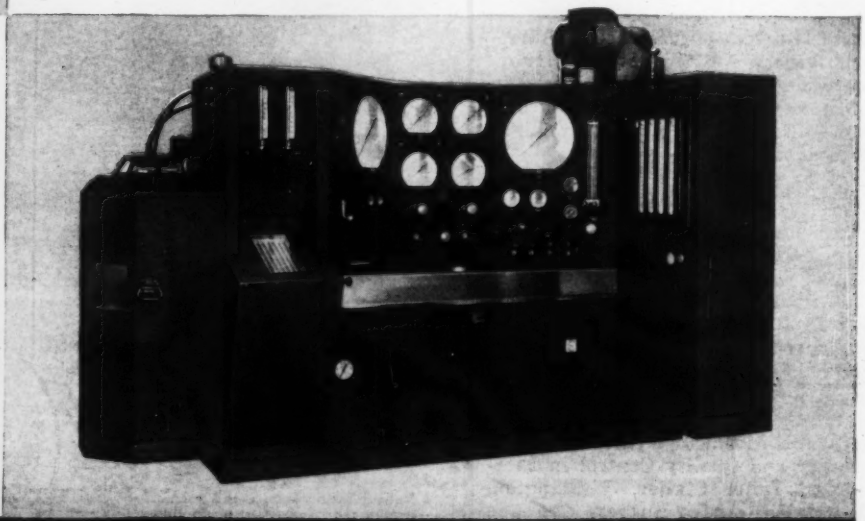
▲

TYPE 12 FLOWMETER

Available in three series — 40, 90, 100 — Cox Type 12 Flowmeters combine high precision performance, outstanding readability, and unusually low cost. All Cox Flowmeters — including the Single Stage Type 8, the automotive Type 10, and the Type 14 for pressures up to 1000 p.s.i. — feature patented "Inner Wall" guides which permit individual matching of tube and float for optimum results.

TYPE 416 UNIVERSAL FUEL NOZZLE TEST STAND ▶

A complete testing "laboratory" designed and built by CRL for determining optimum efficiency of jet airplane fuel nozzles. Now in use by the U.S. Air Force and others. Other CRL products include Cox Calibrating Stands, Carburetor Flow Stands, Magnetic Thickness Gages, Balanced Electronic and Vibration Recording Equipment.



C R L

Commercial Research Laboratories, Inc.
20 BRETLEY AVENUE DETROIT 3, MICHIGAN

For more information circle **14** on inquiry card.

another outstanding feature . . . REEVES

REAC 400

ANALOG COMPUTER

new HIGH SPEED SERVOS

- Bandwidth over 50 cps.
- Velocity 1500 v/sec.
- Plug-in turrets for function generation

New **BUILDING-BLOCK CONSTRUCTION**

Permits assembly of computer elements in any desired combination to do particular job or expand existing installation.

New **CONVENIENT PATCHBAY**

Available in units of 1632, 3264 or 4896 holes for maximum flexibility. Patchboard changes possible during operation.

New **POWERFUL AMPLIFIERS**

Noise less than 3 mv rms **in cabinet.** Phase shift 0.075° @ 100 cps. **in cabinet.** Bandwidth over 10 KC **in cabinet.**

New **HIGH SPEED RESOLVERS**

Vastly improved dynamic performance . . . 35-cycle bandwidth.

★ **Six gang multiplying potentiometers.** Accuracy equivalent to 0.1% linearity potentiometers (over-all multiplying accuracy 0.2% *including mechanical non-linearities).* Two gangs tapped for function generation.

★ **Two front panel plug-in turrets** for padding or feeding voltages into the tapped pots for function generation. Turrets may be stored for future use.

★ **High Speed** — Velocity 1500 v/sec.

★ **Long Life** — Carbon film potentiometer gives exceptionally long life even at high velocities.

★ **Superior Frequency Response:**
Maximum amplitude rise 1.4 @ 40 cps.
Bandwidth over 50 cps.
Dynamic error less than 0.5% of input @ 2 cps.!
Phase shift less than 0.3° @ 3 cps.!

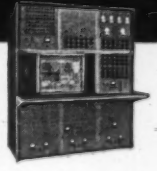
★ **Exceptional low speed performance too** — Typical tracking error less than 0.05 volts maximum for ramp input as low as 0.01 v/sec.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

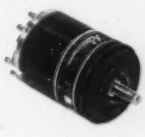
A Subsidiary of Dynamics Corporation of America

225 East 91st St., New York 28, N. Y.

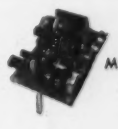


REAC Analog Computers

Precision Floated GYROS



Precision RESOLVERS and PHASE SHIFTERS



SERVO MECHANICAL PARTS

5RV55

For more information circle **15** on inquiry card.

LEWIS SELECTOR SWITCHES
FOR RESISTANCE THERMOMETERS AND THERMOCOUPLE THERMOMETERS

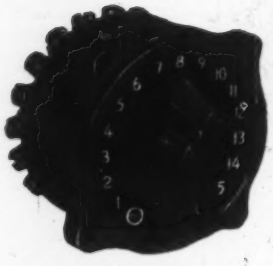
EACH SWITCH HAS "OFF" POSITION PLUS NUMBER OF POINTS LISTED.

Switch Part Numbers

Points	Size	Thermocouple Type	3 Wire Resistance-Thermometer Type
2	2"	11S2	36SR2
3	2"	11S3	36SR3
4	2"	11S4	36SR4
5	3"	10S5	37SR5
6	3"	10S6	37SR6
8	3"	10S8	37SR8
9	3"	10S9	37SR9
10	3"	10S10	37SR10
12	3"	10S12	37SR12
16	3"	10S16	37SR16
18	3"	10S18	37SR18
20	3"	10S20	37SR20
24	4"	27S24B2	38SR24
28	4"	27S28B4	38SR28
40	4"	38S2C	

(No. 38S2C is made with soldering-lug terminals)

2" SIZE



3" SIZE

SPECIAL SWITCHES

No. 37S6C2, Four "4 Point and OFF" thermocouple switches combined in one 3" case.

No. 9S5, Single Pole, Four Point Instrument Switch in 1¼" round case.

No. 44S4, Six Pole, Double-throw Instrument Switch in 2½" round case, one hole mounting, ½-32 threaded bushing.

4" SIZE

DESIGNED FOR TEST WORK AS WELL AS FOR PERMANENT INSTALLATIONS. LEWIS SELECTOR SWITCHES ARE CONSTRUCTED WITH STURDY CONTACTS OF LOW RESISTANCE AND POSITIVE DETENT. THESE SWITCHES ARE SPLASHPROOF, DUSTPROOF AND ARE BUILT TO GIVE YEARS OF SERVICE.

THE LEWIS ENGINEERING CO.

Specialists in Electrical Temperature Measurements

NAUGATUCK, CONNECTICUT

For more information circle **16** on inquiry card.

Trends...

INSTRUMENTS and AUTOMATION

New devices produced in two-decade period 1935-1955 included atomic-energy reactors, jet engines, radar, transistors, electronic computers. New materials included synthetic fibers (like nylon), silicons, antibiotics, titanium. What will next 2-decade period produce?

New research fields are opening in high-pressure and high-temperature. Example: GE development of a reaction chamber that can withstand 1.6 million psi at 5000°F for hours led to synthesis of diamonds. High-temperature and high-pressure instrumentation will become increasingly important.

Low-temperature research and instrumentation is expanding. More than 50 laboratories in the USA now conduct research on ultra-low temperatures; only 2 before World War II. Cryostats that liquefy helium at minus 452° are basic tools.

At turn of century, average industrial worker used 0.1 kw-hr/hour labor; today he uses nearly 7 kw-hr/hr labor.

Reactor instrumentation may exceed $125 million by 1963, predicts Atomic Industrial Forum data. Major reactor markets are 3 in type—propulsion reactors for craft (may be $70 million by 1963), large reactors with output above 25,000 kw (may be $50 million by 1963), small reactors ($7 million by 1963).

Number of engineers graduating with B. S. degrees from the 150 accredited-curricula schools in 1955: Mechanical—4800; Electrical—4100; Civil—3600; Chemical—2000; others-5000.

Median salary per month of graduate engineering students entering industry was $370 for B. S. in 1954, $385 in 1955; $425 for M. S. in 1954, $430 in 1955; $560 for Ph. D in 1954, $600 in 1955.

Estimated 1955 volume of transformers and coils—$200 million; sockets—$25 million; connectors—$17 million; switches—$10 million.

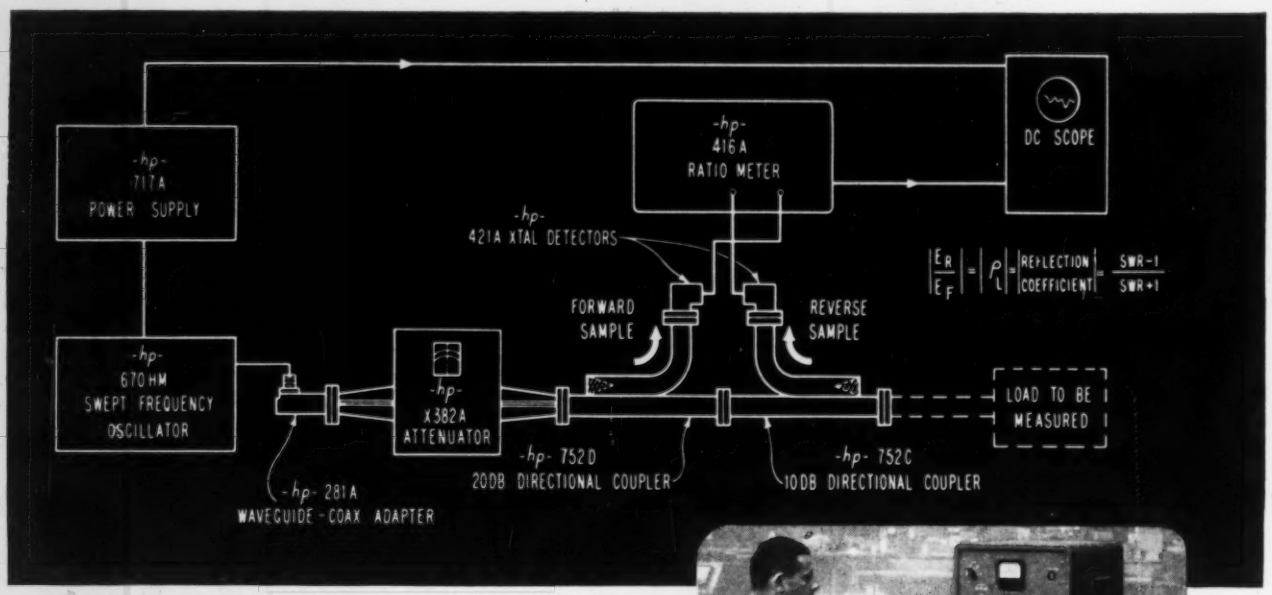
New servomechanism application is stabilization of ship roll by activated-fin stabilizers controlled by gyro-amplifier system. SS Queen Elizabeth and other ships are testing equipment.

Phototube use is increasing at a rate of 100,000 units per year. 1955 volume is forecast as 900,000 units.

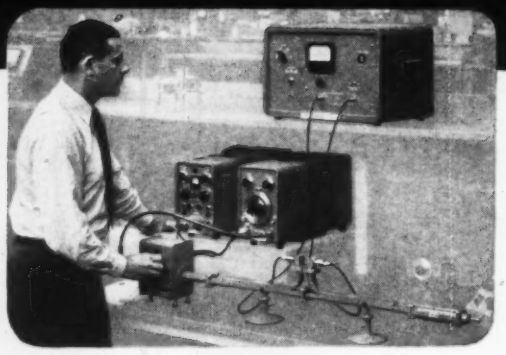
Watch for more startling developments in field of analytical microbalances. I&A disclosure on Peterson microbalance has rocked the field—has highlighted inadequacies in existing balances—has pointed out way to first significant improvement in decades—is even bigger than originally predicted in this publication. I&A will be first with this news from both Mellon Institute and National Bureau of Standards (both now working on development).

The instrumentation of today is the automation of tomorrow.

—R. Rimbach



Reflectometer system. Swept rf power is provided by Oscillator. Directional Couplers sample forward and reverse power. Waveguide Detector Mounts terminating both Couplers demodulate power and present a 1,000 cps signal to Ratio Meter. Oscilloscope presents continuous visual study of reflection coefficient over the swept frequency range.



New!

REFLECTOMETER SYSTEM

for fast, accurate, wide range microwave impedance measurements

- **Instantly measures SWR or reflection coefficient**
- **Continuous swept frequency oscilloscope presentation**
- **Ends tedious checking; unaffected by amplitude variation**
- **Systems for frequencies 2.6 to 10 KMC**

This fast, accurate, practical new reflectometer system eliminates hours of tedious engineering in microwave impedance measurements. It gives direct, instantaneous reflection coefficient or SWR readings, ends need for separate forward and reverse power measurements and does away with corrections for amplitude variation. It provides for continuous oscilloscope or recorder presentation and is easily operated by non-technical personnel. The system includes several new *-hp-* instruments:

***-hp-* 416A Ratio Meter,** automatically combining forward and reverse signals and displaying ratio directly; or provides output for oscilloscope or recorder. Unaffected by amplitude variation. $450.00.

***-hp-* 670 Swept Frequency Oscillators,** three models, covering frequencies 2.6 to 10 KMC. Manually tuned or motor driven to sweep any band at velocity insuring good oscilloscope trace. $1,000.00.

***-hp-* 717A Klystron Power Supply,** specially designed to power *-hp-* 670 Swept Frequency Oscillator. *-hp-* 717A, $375.00.

***-hp-* 752 Directional Couplers,** multi-hole couplers having directivity better than 40 db and very accurate coupling factor. Sampled signals are detected with *-hp-* 421A Crystal Detectors and *-hp-* 485 series Detector Mounts. *-hp-* 752 Couplers, $100.00 to $260.00.

For details see your ***-hp-*** *representative or write direct*

HEWLETT-PACKARD COMPANY

3337C PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.

Cable "HEWPACK"

Sales representatives in all principal areas

Prices f.o.b. factory. Data subject to change without notice.

hp ELECTRONIC MEASURING INSTRUMENTS

For more information circle **17** on inquiry card.

Stock Report . . . . INSTRUMENTS and AUTOMATION

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York

New York Stock Exchange:

Security	Price Range for Year Thru August 31 High	Low	As of August 31, Last
Aeorquip Corp.	17 1/2	8 1/2	15
American C. & C.	42 1/4	35 1/2	41 7/8
American Mach. & F.	35 7/8	25	28 3/4
American Mach. & M.	41 3/8	27 1/2	37 3/4
American Optical	53 1/4	39 1/8	47 1/4
Bell & Howell	42 1/4	30 1/2	38 3/8
Bendix Aviation	59 1/2	45 3/4	48 3/4
Bulova Watch	76	50 3/4	75 1/4
Burroughs	34 1/4	22 7/8	29 3/8
Clevite	25 3/8	20 3/4	22 1/8
Dobeckmun	38 7/8	30 1/4	35 1/2
Ganewell	39	31 1/4	31 7/8
General Inst.	13	9 1/8	9 3/8
General Prec.	71 1/2	44 1/4	46 1/2
General Time	39 3/4	33 1/2	36 5/8
Hamilton Watch	25 1/4	19 3/4	20 1/8 - 20 3/4 (1)
Int. Bus. Mach.	450	349	404
Minneapolis-Hon.	70	53	58 1/2
National Cash Reg.	47	37	39 1/8
Radio Corp.	55 3/8	36 3/4	50 1/4
Raytheon	25 3/4	17 3/4	19
Robertshaw-F.	33 5/8	28	30 3/4
Sangamo Electric	30 3/8	26	26 5/8
Sperry Rand	29 5/8	22 3/8	24 1/2
Square D	52	41 1/4	45 1/4
L. S. Starrett	50	40 3/4	43 1/2
Sylvania Elec.	49 7/8	41	45
Telautograph	37 1/2	25 1/2	29 5/8
Texas Inst.	16 7/8	11 1/2	12 1/8
Underwood	43 1/8	33	39 1/4

(1) Bid - Ask price, no sale.

American Stock Exchange:

Security	Price Range for Year Thru August 31 High	Low	As of August 31, Last
Air Assoc.	12 3/4	8 3/4	9 - 9 5/8 (1)
American Meter	40	32 5/8	37 1/8
Beckman Inst.	26 7/8	19 3/8	21
Benrus Watch	10 7/8	9 5/8	9 7/8
Breeze Corp.	9 3/8	5 3/4	7 3/4
Consolidated Eng.	31 1/4	21 1/4	24 3/8
Du'ont Labs.	17 1/8	13 1/4	14 3/4
ElectroData	17 7/8	10 3/8	13 1/4
Fairchild C. & I.	37 1/4	23 7/8	24 1/2 - 24 3/4 (1)
Int'l Resistance	12 3/8	5	9 7/8
Lear Inc.	13 3/8	8 1/2	8 5/8
Nat'l Res. Corp.	33 1/4	20 5/8	23 3/4
Neptune Meter	28 1/8	21	25 3/4
New Haven Clock	4 1/8	2 1/2	2 3/4
Norden-Ketay	19 1/2	11 1/2	12 3/8
Pneumatic Scale	31	27 1/2	28 - 29 3/4 (1)
Servomechanisms	13 3/8	8 1/4	9 1/2
Wallace & Tiernan	26 7/8	21 1/2	21 3/4
Waltham Watch	2 7/8	1 3/8	2 1/8

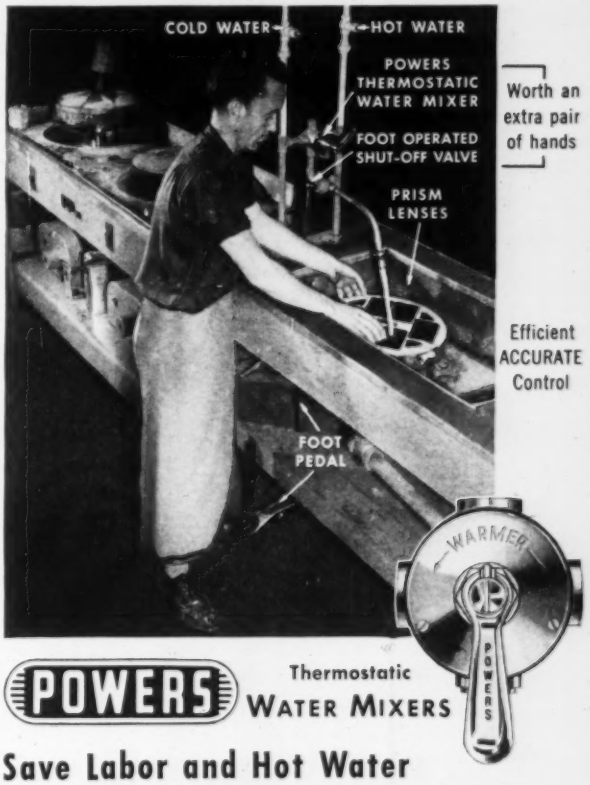
(1) Bid - Ask price, no sale.

Take stock of your future . . .

see ad on page 1783

POWERS Control Helps argus CAMERAS, Inc.

produce high quality precision lenses



Worth an extra pair of hands

Efficient ACCURATE Control

POWERS Thermostatic WATER MIXERS

Save Labor and Hot Water also Help Prevent Damage to Lenses

Photo above shows one of 75 washing operations in ARGUS CAMERAS, Inc. large modern lens polishing department. Here lenses are made for their popular line of cameras, projectors and optical instruments used in our nation's defense.

Combination of a Powers Type H Thermostatic Water mixer and a BRADLEY foot operated shut-off valve releases both of worker's hands for lens washing. Accurate control of water temperature prevents damage to lenses. Instant shut off of washing water by foot operated pedal prevents waste of hot water.

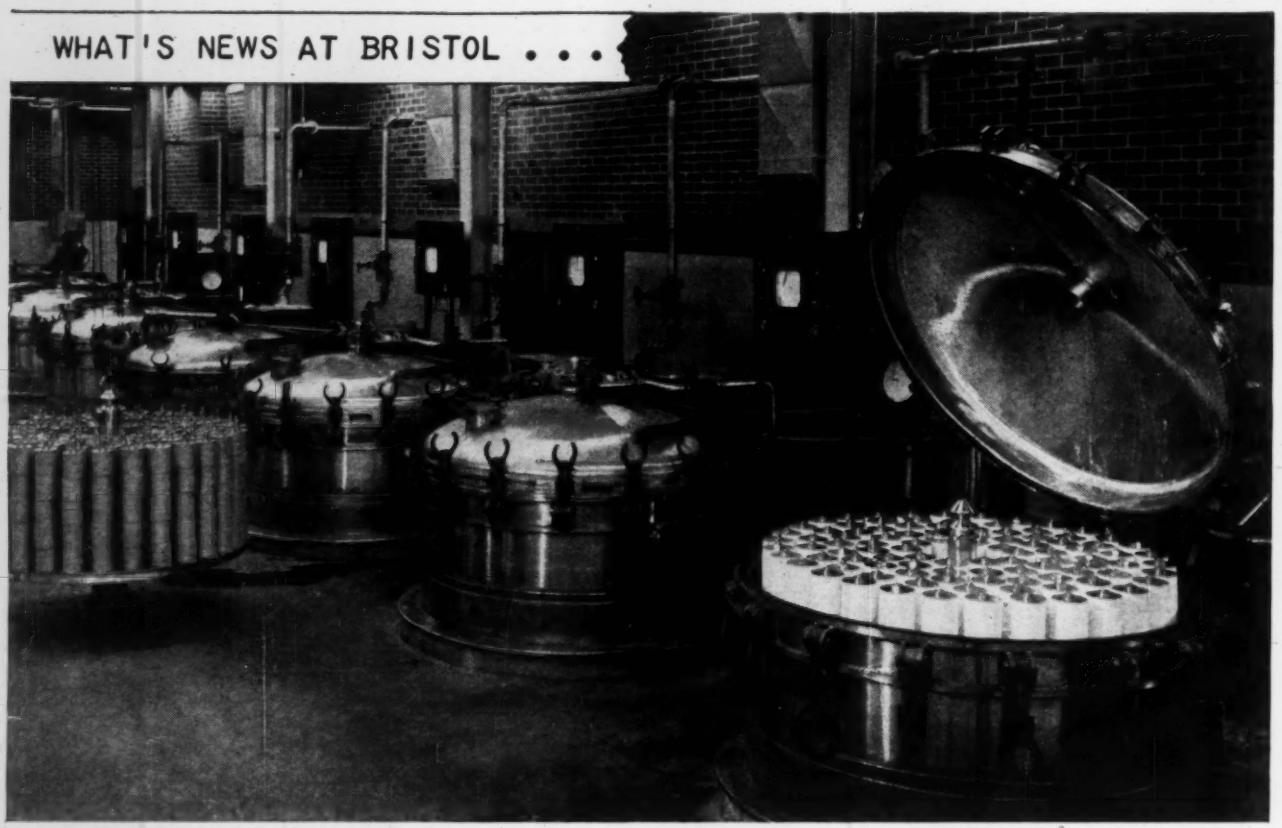
Double-Safety Feature of POWERS Water Mixer shown above: It *thermostatically* mixes hot and cold water and delivers the mixture at any temperature desired regardless of **pressure** or **temperature** changes in water supply lines. Failure of cold water instantly shuts off the delivery. Users often report accuracy of ± ½° F. Capacity 2 to 10 gpm @ 45 psi. *Write for Bulletin 365.*

Larger Capacity Water Mixers available up to 1200 gpm @ 45 psi. Write for Catalog WC. (b66)

THE POWERS REGULATOR CO., SKOKIE, ILL.
Offices In over 50 Cities, see your Phone Book • Established in 1891

For more information circle **18** on inquiry card.

WHAT'S NEWS AT BRISTOL . . .



PUSH-BUTTON AUTOMATION takes over at the new and completely modern thread finishing plant of Coats & Clark, Inc., Toccoa, Ga. Bristol Coordinated Process Control automatically carries out the complete washing and dyeing cycle. Heating, cooling, and reversing of dye flow are automatically controlled and coordinated with the push of a button.

AUTOMATION

Bristol Coordinated Process Control in the field of automation can bring to your plant *lower production costs, new standards of plant efficiency, uniformly high product quality,* and *increased production from present equipment.*

Bristol's completely automatic control techniques make it *economically* possible to get laboratory quality in the factory. There's no more uncertainty in operating sequences too rapid or too complex for human operators – your manufacturing and processing operations are *always* carried out according to the set of conditions known to produce the desired results.

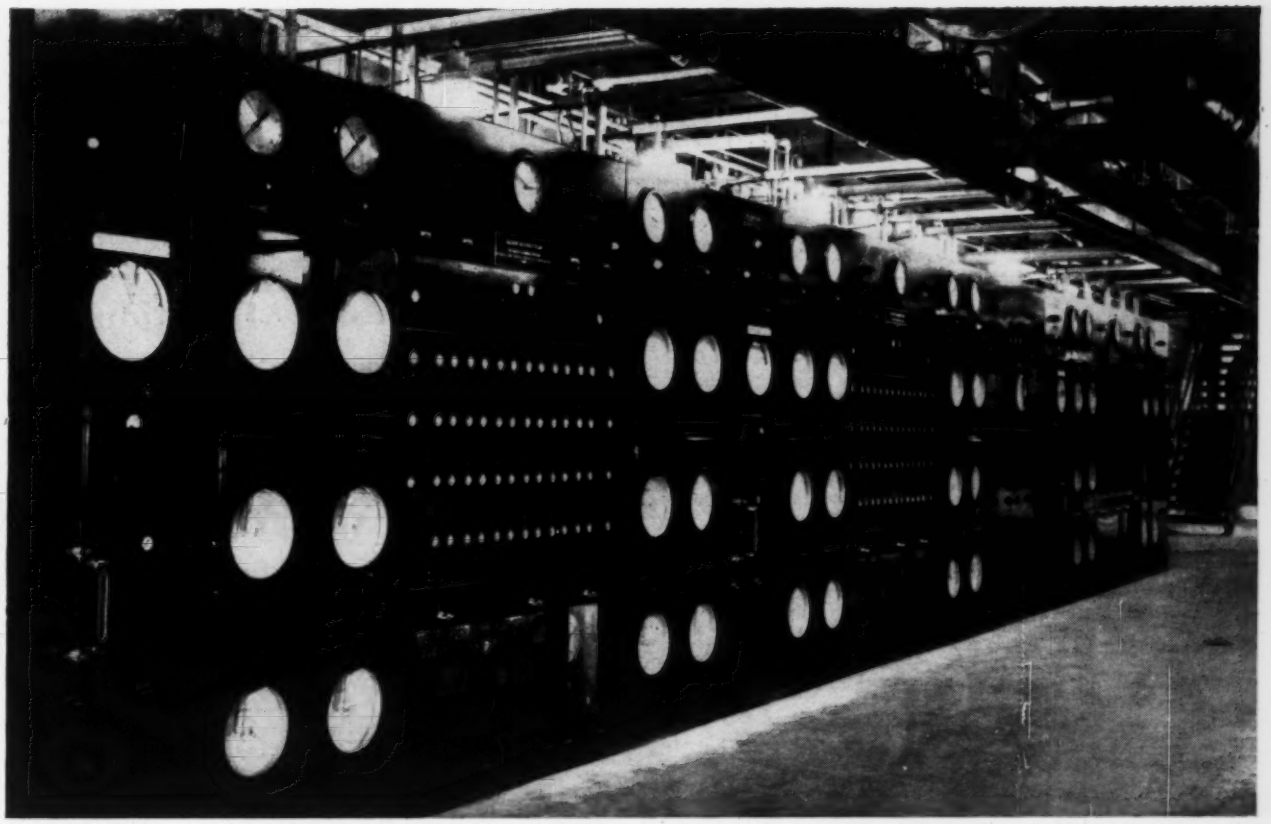
HOW IT WORKS

Bristol Coordinated Process Control Systems automatically control and coordinate all of the variables and operations of a process – such as the time of operation of motors, valves, pumps, blowers, dampers, and the control, at a definite value or according to a time program, of variables that affect the uniformity, quality, cost, and yield of a product – such as temperature, pressure, liquid level, flow, pH, humidity, and speed, as well as others.

The *"Mechanical Brain"* is the leader or director of a Bristol *Coordinated Process Control System.* Under its direction the efforts of all of the instruments are perfectly coordinated. All process variables are accurately controlled and each event takes place in proper sequence.

The *"Mechanical Brain"* makes it possible to build into a control system the exact schedule laid out by the designer of the process. With it, the intended schedule for economical operation is carried out in all details day-in and day-out. Yet the control system is exceedingly flexible. The schedule can be changed at will.

For more information circle **19** on inquiry card.



BRISTOL COORDINATED CONTROL system automatically operates "Columbia"* Activated Carbon Solvent Recovery Plant at American Viscose Corporation's acetate yarn plant, Meadville, Penna. Similar control systems are used in many other solvent recovery installations designed and supplied by Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation. *T.M.–U.C.C.

. . . the answer to high costs

Bristol Coordinated Process Control Systems are made possible only by the following facilities, developed during 66 years of experience:

1. Bristol's complete line of Automatic Controlling, Recording, Electronic, and Telemetering Instruments.
2. Bristol's Time Cycle Controllers.
3. Bristol's ability to combine electronics and the mechanical phases of automation.
4. Bristol's experienced engineering staff.

HAVE YOU AN AUTOMATION PROBLEM? Our engineers would like to work with you on your problems of automation and process control. Write today for further information. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 5.27

BRISTOL PRODUCTS:

Automatic Controlling, Recording, and Telemetering Instruments for:

Pressure, Vacuum, Absolute Pressure, Draft, Differential Pressure, and Barometric Pressure.
Temperature (Thermometers, Potentiometers and Pyrometers).
Flow, Water and Liquid Level, and Specific Gravity.
pH and Conductivity.
Speed of Travel and Rotation.
Humidity.
Voltage, Current, Power, and Load Totalization.
Mechanical Motion, Position and Operations.

Including:

Automatic Control Systems
Electronic Potentiometers
Graphic Panel Instruments
Time-Cycle Controllers
Time-Program Controllers
Pneumatic and Electric Controllers
Instrument Panels
Control Valves

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

TRADE MARK BRISTOL'S REG. U.S. PAT. OFFICE

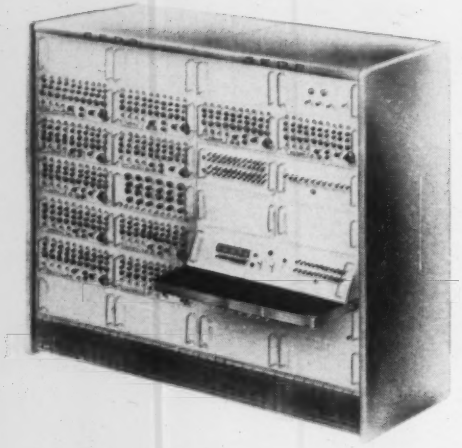
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

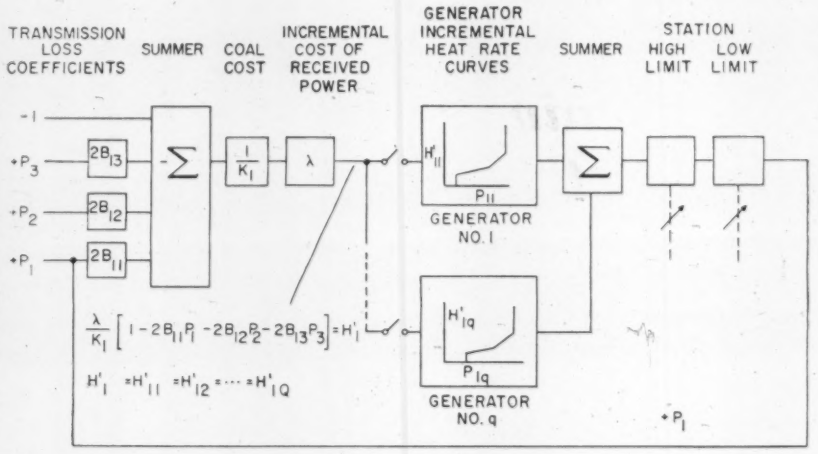
For more information circle **19** on inquiry card.

News...

INSTRUMENTS and AUTOMATION

Ohio Edison Plans GEDA Control of Power Allocation





MASSILON, OHIO.—The nine plants and more than 30 generating facilities of the Ohio Edison power system soon are to be controlled by a special-purpose analog computer (GEDA) of Goodyear Aircraft Corp., Akron 15, Ohio. The computer will automatically solve for optimum allocation of power based on transmission losses, fuel costs, station incremental heat rates, etc. This data will be fed to a Leeds & Northrup load-control console (an existing facility) to control all the generators with the system at the point of maximum efficiency.

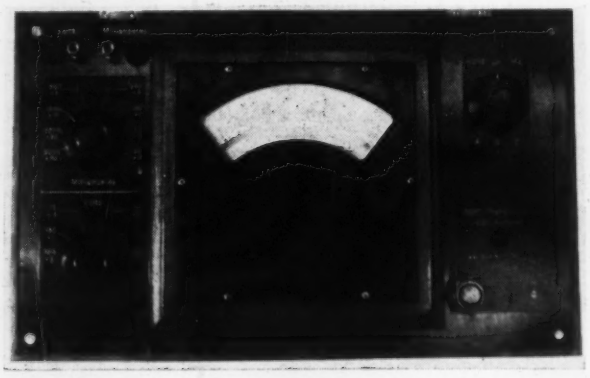
Shown is the standard cabinet version of the GEDA Goodyear Economic Dispatch Computer. Also shown is a block diagram of a "station simulator," the basic method by which the computer will solve the equations for coordinating all the generator facilities. Loss coefficients and incremental heat rate data for each generating unit are inserted into each station simulator (a chassis on the computer). The switches on the front of each station simulator are set according to the availability or nonavailability of the generating units at that station. Station low-limit and high-limit controls also are set, as required. Cost of fuel also is stored by means of a dial.

At the console the dispatcher then sets the values and directions of tie-line powers. A recorder can plot incremental cost of received power (λ), incremental heat rate, etc., as a function of total system generation. Additional inputs showing system deviation are used to make the system completely automatic—that is, to balance all facilities at optimum efficiency. Goodyear Aviation will present clinic sessions on GEDA computers at the forthcoming Computer Clinic, Second Automation Exposition, Nov. 15-17, 1955.

Accurate Audio-frequency Instruments

WASHINGTON, D. C.—Two new instruments devised by the National Bureau of Standards make quick, accurate measurements of audio-frequency current and voltage possible. The *volt-ampere converter* (Fig. 1) provides 0.05-percent accuracy for laboratory use in conjunction with a d-c potentiometer. The *thermocouple volt-ammeter* (Fig. 2) is a portable, direct-reading device with an accuracy of 0.5 percent. Development was carried out by F. L. Hermach and E. S. Williams of the NBS electrical instruments laboratory.

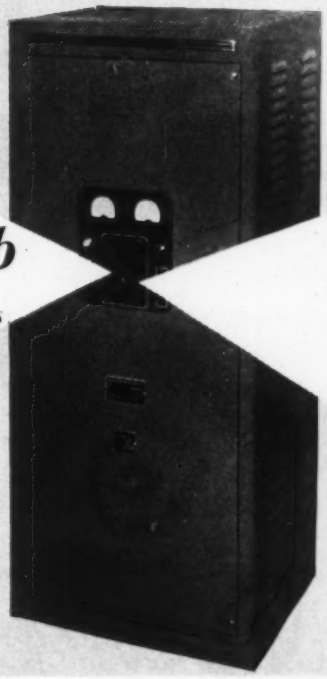
Instruments that can accurately measure alternating currents and voltages at frequencies as high as 20,000 cps, the upper limit of the audio range, are now needed owing to increasing use of these ranges for weight saving reasons. Because NBS primary electrical units standards are d-c in nature, highly accurate electrothermic transfer



Volt-ampere Converter

Here's the versatile, regulated DC source you've been looking for -

NOBATRON* Ranger



turning this knob gives you . . .

100-300VDC at 1-10 amps
(model SR2)

5-135VDC at 1-10 amps
(model SR100)

5-30VDC at 3-30 amps
(model SR30)

with ±0.25% regulation accuracy!

The Sorensen Nobatron-Ranger is essentially an adaptation of the proved Nobatron circuit**, with the added feature of continuously adjustable output voltage over a wide range. This makes the RANGER an exceptionally good investment for the many laboratories and test installations where a multi-purpose DC source can be used to advantage.

ELECTRICAL CHARACTERISTICS

Input voltage range	95-130VAC, 1Ø, 50-60~ for models SR30 and SR100 190-260VAC, 1Ø, 50-60~ for model SR2
Output voltage and load range	5-30VDC at 3-30 amps in model SR30 5-135VDC at 1-10 amps in model SR100 100-300VDC at 1-10 amps in model SR2
Regulation accuracy	±0.25% at any output voltage setting with an input between 105 and 125VAC. The accuracy will be slightly less at the extreme value of the input.
Ripple	1% RMS max. of output setting

All RANGERS are 22" wide by 17¼" deep by 47¼" high. They are self contained in handsome cabinets, equipped with casters for easy mobility. Meters are furnished as standard equipment, and there is adequate protection against overload, overvoltage, and tube filament failure.

Write for further information, and for your free copy of the new Sorensen general catalog, to Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. In Europe, please correspond directly with Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

*Reg. U. S. Pat. Off./**Model SR2 uses a circuit device patented by Wm. J. Brown.

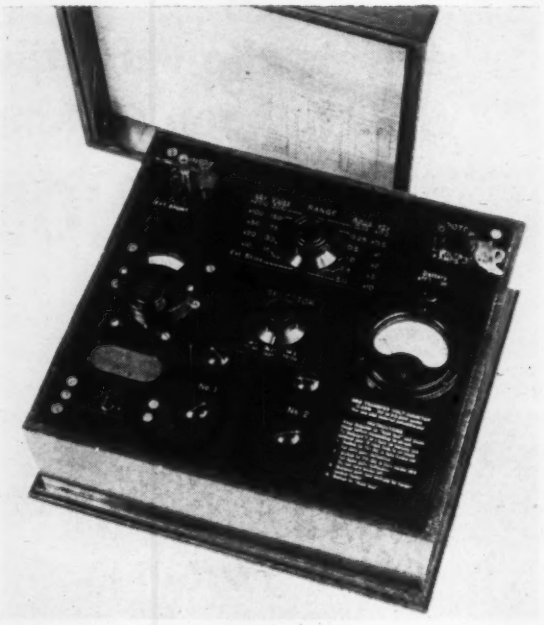
For more information circle **20** on inquiry card.

standards had to be developed which can be calibrated on direct current and then used in audio-frequency measurements of voltage, current, and power.

The NBS electrothermic transfer instruments make use of thermal converters, consisting essentially of a conductor (heated by the alternating current to be measured) and a thermocouple, one junction of which is thermally connected to the heater at its midpoint. This principle has proved to be of high accuracy over wide frequency ranges.

In the volt-ampere converter, a built-in galvanometer indicates balance of the thermocouple emf and an internal d-c "bucking circuit." The heater is then switched to an internal d-c circuit, which is adjusted to give the same output emf and, therefore, equivalent heater current and voltage drop, which are measured by an external potentiometer in the 0.05-percent accuracy range. The portable instrument is self-contained and requires no external d-c source or controls.

The thermocouple volt-ammeter is a conventional multirange instrument with added circuits which permit checking of its thermoelement by its own indicating instrument.



Thermocouple Volt-ammeter

Automated Garment Handling

Los Angeles, Calif.—Shown is a portion of a 3500-foot Chainveyor conveyor system recently installed in the new warehouse of the Broadway Department Store, Los

Angeles. This system uses automated handling techniques that are said to be the "most modern and efficient in the industry." More than 6000 garments are received, sorted, marked and segregated within a 2-hour period. The Chainveyor Corporation is conducting a clinic sessions on the new techniques at the forthcoming Conveyor Clinic, Second Automation Exposition, Chicago Navy Pier, Nov. 15-17, 1955.

New Computing Center

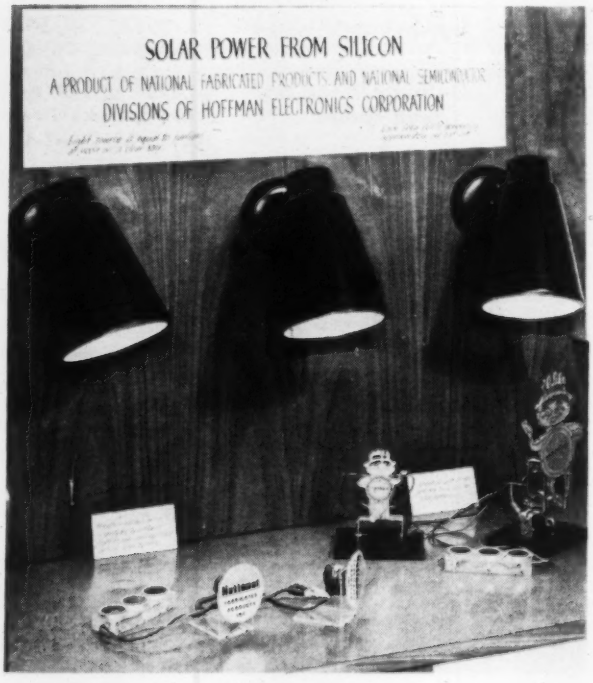
White Plains, N. Y.—Nuclear Development Corporation of America (NDA) will establish a Westchester County Computing Center here which will not only serve its own needs for computing machinery in its reactor design and development program, but also will be available to other organizations which plan to utilize computing machine methods in their business.

"Datatron," a high-speed digital computer manufactured by the ElectroData Corporation of Pasadena, Calif. will be the first computing machine of the center. Additional machinery will be built or purchased as the need arises. NDA electronics and mathematics staffs will be available to industries and commercial firms interested in solving problems by computing machine.

Solar Power

San Francisco, Calif.—Power from a light-energized silicon battery operated these small electric motor and oscillator units at the Hoffman Electronics display at the WESCON show, Aug. 24-26, San Francisco.

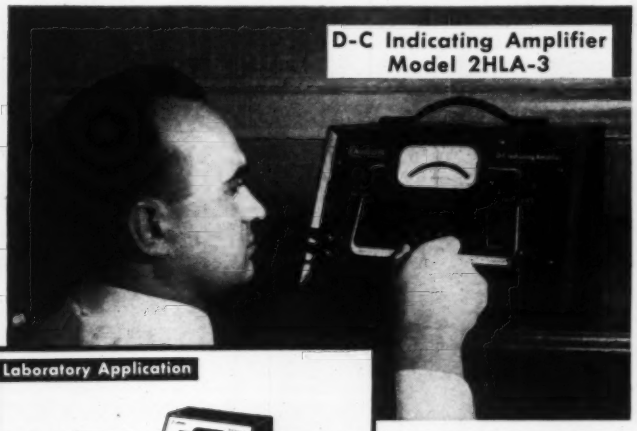
National Fabricated Products and National Semiconductor Divisions of Hoffman Electronics Corp. are the

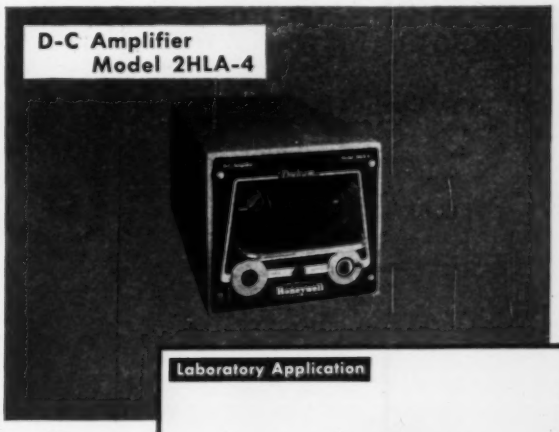

SOLAR POWER FROM SILICON
A PRODUCT OF NATIONAL FABRICATED PRODUCTS AND NATIONAL SEMICONDUCTOR
DIVISIONS OF HOFFMAN ELECTRONICS CORPORATION

NEW DOELCAM PROPORTIONAL AMPLIFIERS OFFER GREATEST VERSATILITY IN LOW LEVEL D-C SIGNAL APPLICATIONS

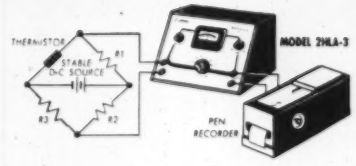
HERE ARE TWO PRECISION AMPLIFIERS incorporating the new *Doelcam Second Harmonic Magnetic Converter* as the input stage. This unique design concept makes possible low noise level, high sensitivity and linear output.

The Model 2HLA-3 is both a Linear Indicator and a Multirange Amplifier. The Model 2HLA-4 is a Single Range Amplifier with provision for interchanging range by plug-in units. Both are ideal for either laboratory or production use.



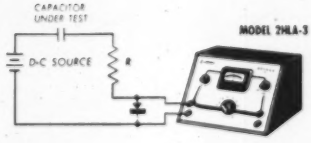


Laboratory Application



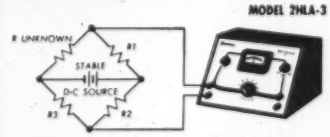
The fast thermal response of highly sensitive thermistors can be accurately measured and recorded.

Production Application



Measuring the dielectric leakage current of capacitors.

Production Application



Production testing of precision resistors or potentiometers in a balanced bridge circuit.

Write for Bulletin 1A-4 Write for Bulletin SRA-4

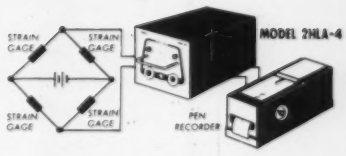
WHETHER YOUR APPLICATION is in the laboratory or on the production line, one of these two instruments is ideally suited. Their versatility is illustrated in the diagrams shown here. The Model 2HLA-3 is both a precision measuring laboratory instrument and a rugged production test instrument. The Model 2HLA-4 is designed for rack mounting as a component part of a control or measuring system.

HERE ARE SOME PERFORMANCE CHARACTERISTICS:

- High Gain — 10^4 for 2HLA-3, 10^5 for 2HLA-4
- Low Noise — less than 5 microvolts equivalent input
- Linear Amplification—better than ± 1% on all ranges
- High Stability — zero drift less than 10 microvolts
- Rugged — withstands inputs of 1.5 volts

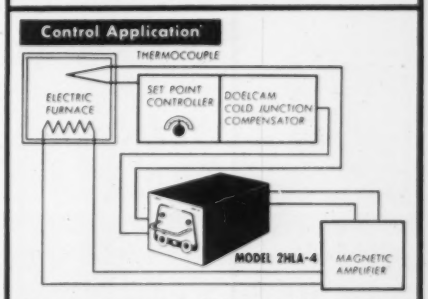
SPECIAL APPLICATIONS: These instruments can be easily adapted to provide linearity down to 0.1%, isolated input, multiple inputs, increased gain, increased power output and extended frequency response. Send us your complete requirements.

Laboratory Application



Dynamic stress measurements made with linear response up to 20 cps.

Control Application



Temperature control within a small temperature range.

Doelcam

A DIVISION OF MINNEAPOLIS-HONEYWELL

H HONEYWELL

SOLDIERS FIELD ROAD
BOSTON 35, MASS.

Instruments for Measurement and Control

Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

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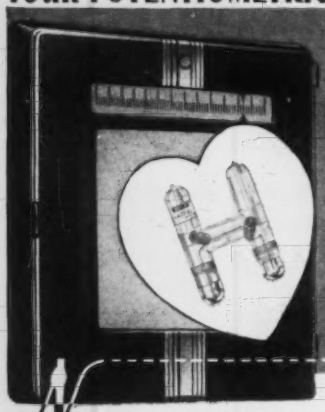
YOUR POTENTIOMETRIC INSTRUMENTS



HAVE A HEART TOO!

NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle **22** on inquiry card.

first commercial manufacturers of the silicon battery, or "Solar Battery."

The "Solar Battery" is a thin wafer about the size of a half dollar. It has two electric terminals like any other battery and, when exposed to light, will generate about half a volt. Three wafers generate sufficient power to operate the motor or oscillator display; a square yard of the batteries would run an electric fan; an acre or two would give enough power for a fair-sized town.

Allstate Uses Computer

PASADENA, CALIF.—Allstate Insurance Co. recently has announced installation, at its Skokie, Ill. home office, of an Electrodata Corp. "Datatron," a medium-sized digital

computer, to simplify the paperwork involved in automobile, personal liability, and fire insurance operations for over 3 million policyholders.

It is reported that initial 1,800 man-hours for preparing a quarterly report for underwriting, comprising data from 2,100 licensed agents, were cut last year by office machines to 100 hours, while the computer now compiles the report in just 12 hours. It is expected that Datatron will pay for itself in two years, with savings accruing chiefly from release of rental equipment.

Automatic Water Plant

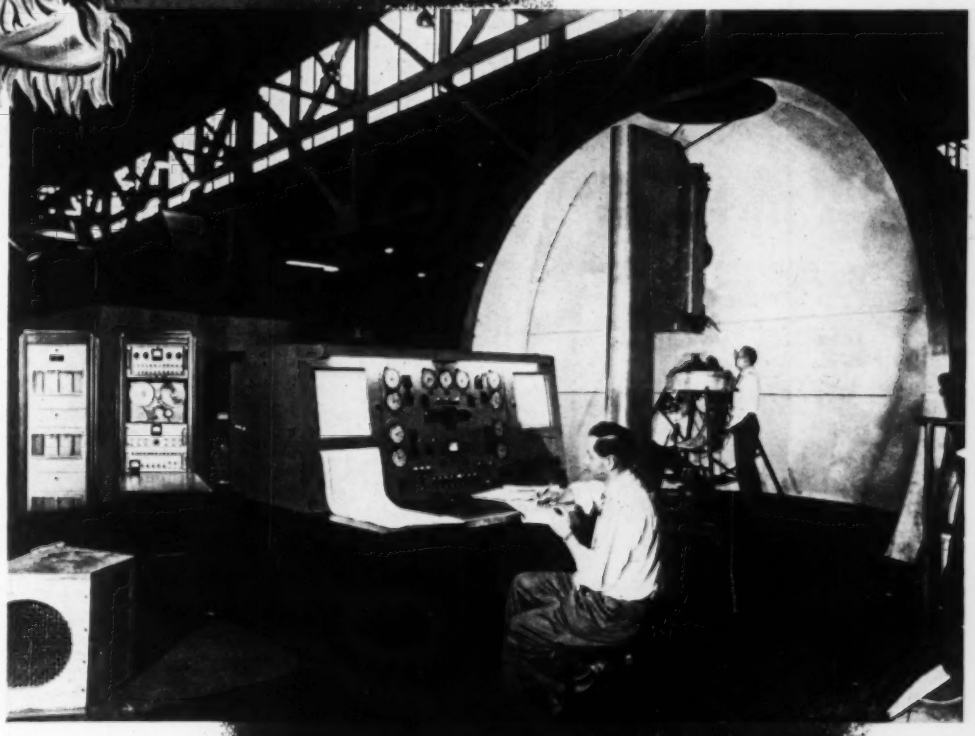
FORT HOOD, TEXAS.—A contract in excess of $65,000 to build an automatic control system to monitor operations of a new $1,000,000 water filtration plant here has been awarded to Minneapolis-Honeywell Regulator Co., it was announced recently. The new plant will be capable of supplying more than 7½ million gallons daily. Control system will be primarily pneumatic.

Automatic Ticket Reservation

CHICAGO, ILL.—New mechanical and electronic devices have been installed by United Air Lines for handling airline reservations and ticket sales. Used in conjunction with IBM machines and automatic ticket printers, they introduce automation in procedures long dominated by hand methods. The devices include (1) "Unisel," developed by Teleregister Corp., a central electronic brain, keeps track of the rapidly fluctuating number of seats for sale on various flights of various days; (2) "Ticketeer,"

Takes more than a quick eye

TODAY!



12-Information Channel-Playback System for use with The Glenn L. Martin Co.'s new T-13 Gunnery Trainer, designed and developed by Cook Research Laboratories, a division of Cook Electric Company.

AIMING HIGH

"drawing a bead." Split-second timing is absolutely essential [illegible] of the intricate instrumentations and equipment necessary to give [illegible] training in gunnery to both our anti-aircraft troops and to our jet [illegible]

Eleven STANDARD ELECTRIC Model S-1 Timers are shown on the large control panel in the center of the photograph above.

STANDARD

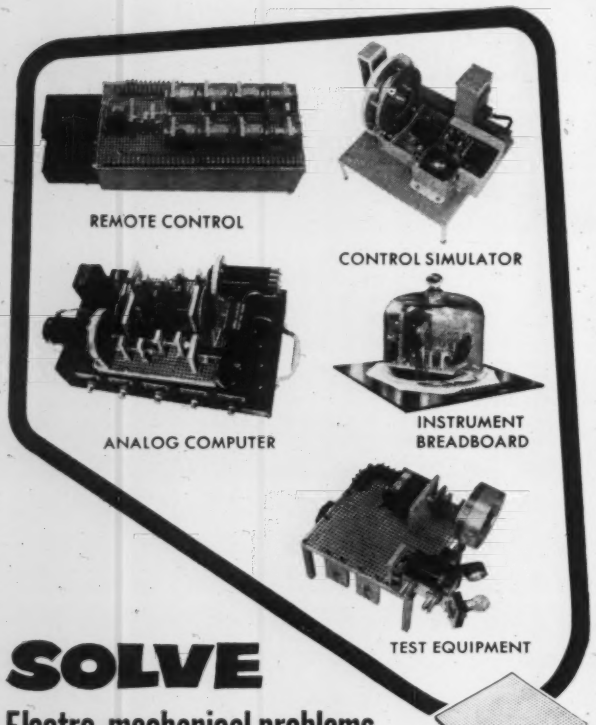
Serving industrial, governmental and educational institutions since 1884.

The STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET · SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

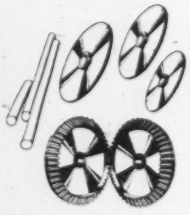
For more information circle **23** on inquiry card.

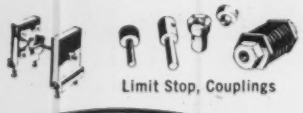


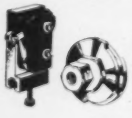
SOLVE

Electro-mechanical problems... IN THE LAB! with Servomechanisms' efficient, economical Mechanical Development Apparatus

Pictured above are typical Mechanical Development Apparatus (MDA) assemblies, complete with electrical components. MDA is an assortment of standardized, precision-built, mechanical components designed for the purpose of simulating instrument and control systems in the breadboard phase of development. The apparatus makes designing extremely fast and economical. An appropriate group of these versatile units can be quickly assembled into a desired mechanism. The components lend themselves to endless use and re-use due to flexibility of design. Only a small assortment is needed to cover a multitude of problems. Prove out your design, quickly and economically with these versatile "tools."







SERVOmechaNISMS INC.

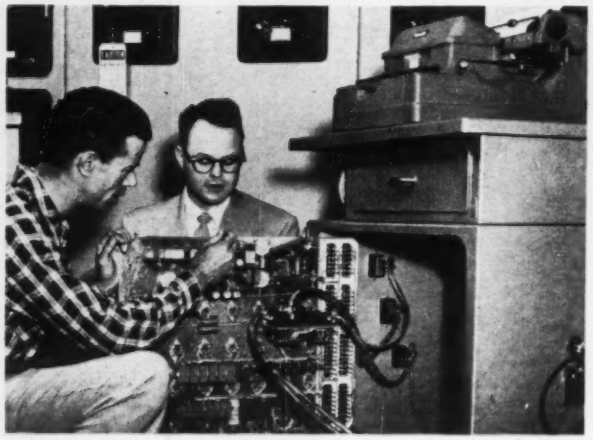
For complete information write for catalog to...
COMPONENTS DIVISION
625 Main Street
Westbury, L. I., N.Y.

For more information circle **24** on inquiry card.

manufactured by Burroughs Corp., produces a complete ticket in less time than it takes to read about here; (3) "Unitran", a high speed form of facsimile, developed for United by Western Union reproduces reservations card at the sales center. The card is then processed by key-punching by an IBM machine operator for filing and sorting. Sorting which previously took 5 hours is now completed in 30 minutes.

Typewriter Records Reactor Temperatures

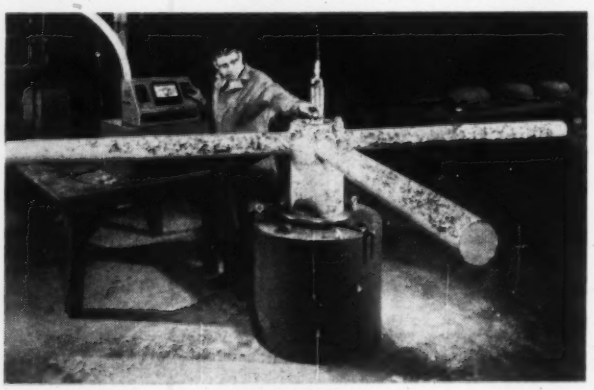
RICHLAND, WASHINGTON.—General Electric scientists now use a typewriter to collect temperature data from inside the plutonium-producing huge Hanford Atomic



Products Operation piles. Voltage signals originating from the thousands of thermocouples inside the piles are translated by complex equipment into code signals. These signals trigger typewriter keys which print the proper temperature on a chart of thermocouple locations. Previous charting time of hours is now cut to a few minutes.

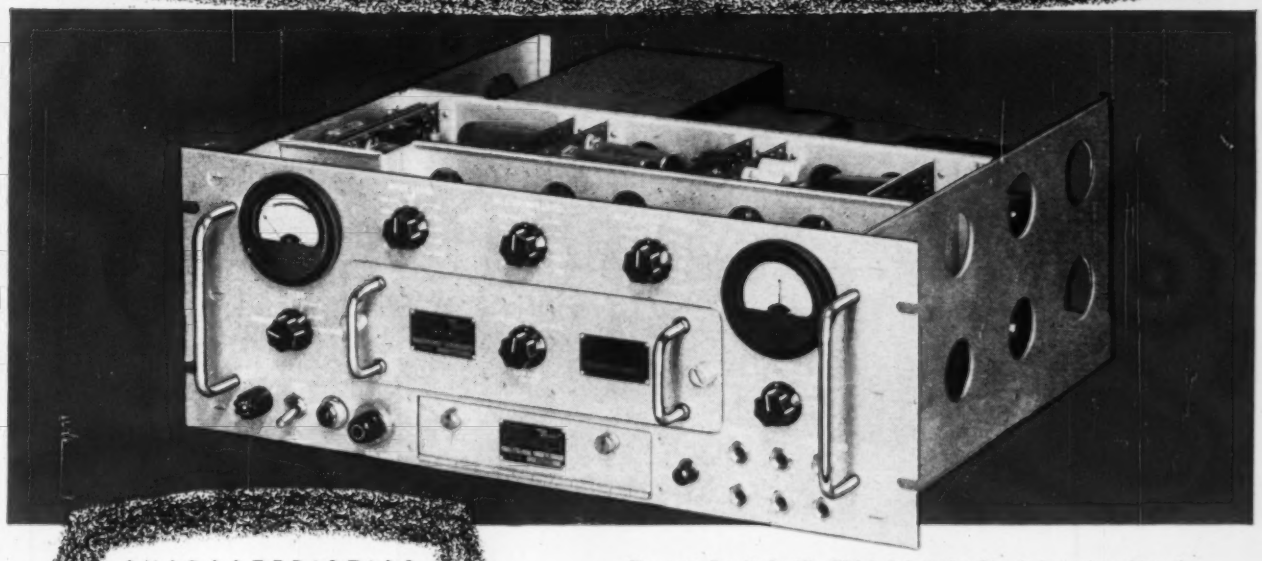
Balancer Uses Strain Gages

PHILADELPHIA, PA.—Static balancing of rotating parts such as cooling fans and helicopter rotors can be done now with an accuracy as high as 2 inch-ounces on parts weighing up to 2000 pounds. Dean & Benson Research, Inc. has developed a vertical balancing rod on which a Baldwin SR-4 resistance-wire strain gage is bonded. Bend-



(*Continued on page* 1606)

BENDIX - PACIFIC
DISCRIMINATORS
FOR FM/FM TELEMETERING RECEIVING STATIONS



CHARACTERISTICS

Center Frequency
250 cycles to 110 kc

Deviation
±5% to ±40% of center frequency

Frequency Response
DC to 40% of bandwidth

Input Signal
0.01 volt rms minimum per subcarrier and 15 volts rms maximum for composite of all subcarriers

Amplitude Modulation
Less than 1% of bandwidth change for 10 db input steps

Output
3 single ended outputs providing 20 ma of output current

Stability
±0.4% after one hour warming

Sensitivity Stability
±0.25%

Linearity
±0.1% from best straight line

Power Source
105 to 125 volts, 60 cycles, 200 watts nominal

The new Bendix-Pacific TDA-9 Subcarrier Discriminator provides the accuracy and stability necessary to permit expansion of Frequency Modulation telemetering systems into high precision and automatic data handling facilities.

Normal, extended or reduced intelligence frequency response is selected by a switch. Signals from proper impedances are of sufficient level to directly accommodate many of the commonly employed data recording and handling equipment without additional amplifiers. Freedom from drift and gain instability is maintained by a chopper-stabilized DC amplifier.

The design of the band pass filters used in the TDA-9 discriminator includes a flat response over the pass band, a linear phase shift characteristic to provide constant time delay of the intelligence signal, and selectivity to provide adequate channel rejection, preventing systems intermodulation.

Provisions for fine balance adjustment of center frequency from a remote location as well as wow and flutter compensation during tape recorder playback have been provided.

Standard discriminators are available for operation on all RDB bands. The unit is also operable over an extended frequency range with center frequencies of 250 cps to 110 kc without deteriorating the performance characteristics. Operation using wide deviations up to ±40% of the channel center frequency can be provided.

Bendix
PACIFIC DIVISION
Bendix Aviation Corporation
NORTH HOLLYWOOD, CALIF.

EAST COAST OFFICE: 475 5th AVE., N.Y. 17 • **DAYTON, OHIO**—1207 AMERICAN BLDG., DAYTON 2, OHIO • **WASHINGTON, D.C.**—SUITE 803, 1701 "K" ST., N.W.
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Something New Under The Sun!

SEALED—RUGGEDIZED INSTRUMENTS BY ROLLER-SMITH HAVE THAT "NEW LOOK" FOR

Perfect Readability: New shrouds designed by leading industrial designers focus attention to the large dial, assuring "ease look" readability and instrument appearance.

Greater Accuracy: New zero adjuster permits "split-second" adjustment from the front. No danger of leaks.

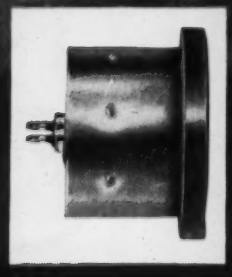
Simplified Maintenance: New gasket seal perfected by Roller-Smith permits easy disassembly for ... soldering equipment—the sealed glass cover has the same glass easily and ... Cases are reduced.

Roller-Smith ... and ruggedized instruments feature these three outstanding engineering and design improvements in all sizes from 2½ to 6½ inches to make them the most advanced on the market. Available in all practical ranges of AC and DC for accurate measurement under extreme environmental conditions.

Consult our engineering staff with over 50 years experience to solve your specific research and development problems.

Designed to comply fully with MIL-M-6A and MIL-M-10304 (Signal Corps.)

An extra feature—new "wrap around" shroud with gasket seal makes these meters as modern in appearance as they are in performance. Properly built, their most functional lines express the forward thinking of our engineers.



ROLLER-SMITH

Instruments for Industry

WEST MARKET STREET BETHLEHEM, PENNSYLVANIA

Precision Products Since 1880

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Circle **27** on inquiry card. ⟶

force!

When you want to measure it look to **Brush Recording Systems**

Torque of an engine balancer shaft is recorded by Brush instrumentation in this set-up at Caterpillar Tractor Co. Test data helped Caterpillar engineers reduce vibration, improve engine performance.

A boxer's punch, a heart's contraction, a piston's thrust—you can measure almost any form of force with Brush Recording Systems. These versatile instruments give you the answers in writing, charting instantaneously as phenomena occur. Brush offers a complete line of portable, console or rack mounting oscillographic systems for recording 1, 2, 4 or 6 channels of data.

These and other Brush instruments can help you in virtually any measurement problem involving electrical, mechanical, heat, light, sound or nuclear quantities. For complete information, call or write Brush Electronics Company.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH 6 ELECTRONICS

Division of Clevite Corporation

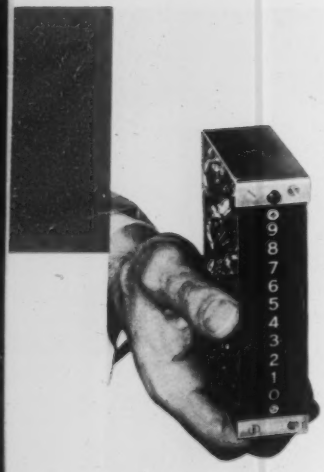
NEW IDEAS IN MEASUREMENT FROM BRUSH

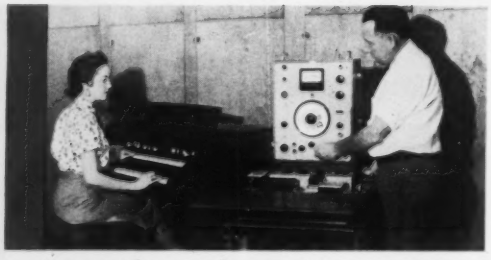
Chooses best recording speed.

Test engineer has a choice of up to 16 recording speeds on this Brush Recording System. Result—he can choose the best speed for the signal being measured for optimum accuracy and clarity of chart records. Wide speed range helps economize on chart paper too! Systems like this can record a wide range of electrical or mechanical variables.

How well does he breathe?

This diver is entering a pressure chamber for a "dry-land dive" at various simulated depths. Through strain transducers, Brush recording instruments chart the pressure of the diver's breathing and the rate of air flow. Tests help evaluate physical effects on the diver as well as performance of equipment.





Keeps the music sweet.

This test set-up at Hammond Organ uses a Brush Frequency Response Recorder to test the ringing time of tone generating circuits. Brush offers an integrated line of precision equipment for measuring sound, noise, vibration, analyzing frequency spectra, etc. Chart records simplify analysis and provide permanent records of tests.

Counts anything?

The "Countess"—Brush's outstanding digital counter—counts anything up to 100,000 pulses per second. Unit requires only one-half the voltage, one-fourth the power needed by conventional counters. The result is less heat, greater reliability. Use the Countess as a component in equipment: for testing, controlling, computing, etc.

Call BRUSH for the answer!

For help in your measurement problems, call your nearby Brush representative, or write Brush Electronics Company, Department 77, 3405 Perkins Avenue, Cleveland 14, Ohio. Your request will receive prompt attention!

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH 6 ELECTRONICS

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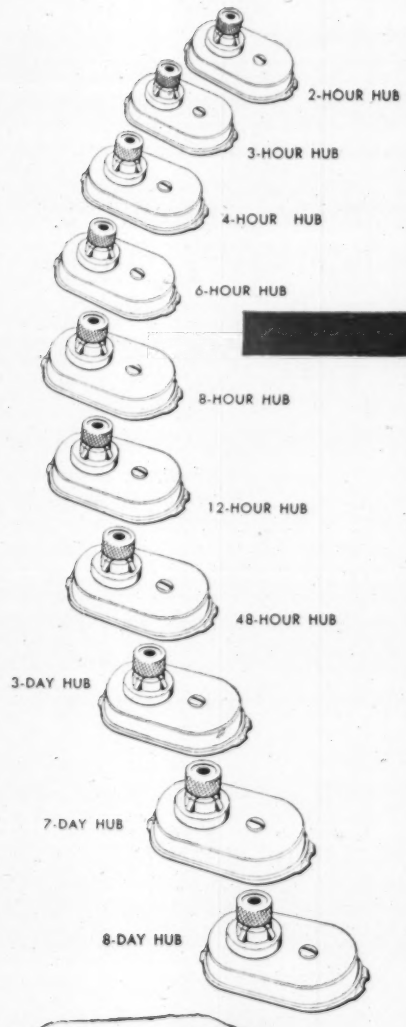


Is Your Chart Drive Inventory Ready for Cold Weather?

JUST STOCK BASIC
ROCKWELL CHART DRIVES
plus a selection of inexpensive
SPEED CHANGING TURRETS

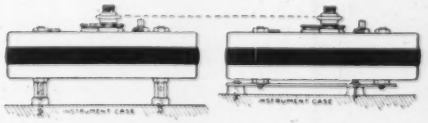
FOR REPLACEMENT SERVICE, the Rockwell chart drive is the most versatile, economical you can use. Design dimensions were deliberately established so that the drive can be adapted to fit practically all instruments. One adaptor is furnished with each drive. There is no problem with rotation rates either. Speed changing turrets lock onto the chart arbor of the Rockwell drive to provide any one of 11 rotation cycles. Think what these features mean to you in reduced chart drive inventory, servicing and all-around flexibility of application.

Get facts now on versatile, long-lived Rockwell chart drives. Learn how their use in your instrument shop will save time and money. Write for bulletin 1079.

The Turret On Top Does The Trick

Illustrating how the speed changing turrets are applied to the chart arbor to provide a wide selection of rotation rates.

ADAPTORS TO FIT PRACTICALLY ANY INSTRUMENT



Illustrations show how adaptors are used to correctly locate Rockwell chart drives within instrument cases both as to position and height.

YOU CAN RELY ROCKWELL ON ROCKWELL

ROCKWELL MANUFACTURING COMPANY
INSTRUMENT DIVISION • BOX 2396, TULSA, OKLA.

Atlanta • Boston • Charlotte • Chicago • Dallas • Houston
Los Angeles • Midland, Texas • N. Kansas City, Mo. • New York • Philadelphia
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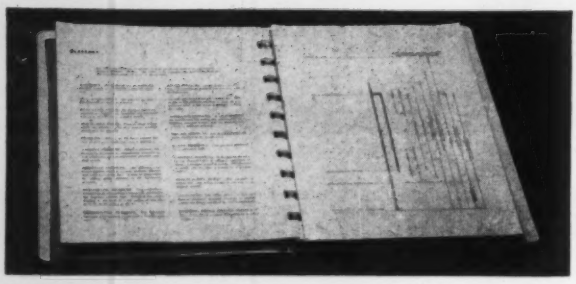
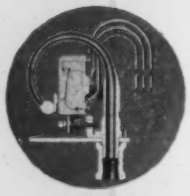
FREE



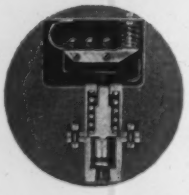
THE ONLY
COMPLETE HANDBOOK
ON PRESSURE & VACUUM SWITCHES

As an aid in planning the vital link between your electric and hydraulic circuits, this manual contains a glossary of terms and a schematic demonstration of operating characteristics. Functions and methods are described in detail and liberally clarified with diagrams and illustrations, including symbols for circuit detailing and specification purposes. To provide the means for proper selection of a pressure switch for your specific application, a simple step by step selection chart has been developed helping you to organize your requirements in their relative order. Finally a complete run-down, illustration and tabulation of all the detail features leading to the unit that answers your specific control problem. You couldn't buy a comparable handbook.

FOR EXTREME ACCURACY,
Diaphragm and Bourdon Tube Switches
Vacuum to 12,000 P.S.I.



FOR EXTREMELY LONG LIFE,
Piston Switches, Low Settings — High Proof Pressures to 15,000 P.S.I.



FOR HAZARDOUS LOCATIONS
Explosion-Proof Models

ALL SWITCHES operate in any position, are not sensitive to vibration.

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ing strains in the rod are detected and measured by an electronic unit developed by Ruge-deForest, Inc., affiliate of Baldwin-Lima-Hamilton Corp.

Viscometer Improves Open-hearth Operation

CINCINNATI, OHIO.—The Cincinnati Division of Bendix Aviation Corp. and Standard Steel Works of Baldwin-Lima-Hamilton have cooperated in developing a fresh approach to the objectionable absorption of sulfur from the high sulfur Bunker C (No. 6) fuel oil in acid-open-hearth furnaces.

A Bendix Ultra-Viscoson electronic viscometer is applied to maintain uniform viscosity of a mixture of Bunker C and diesel oil which is used until the slag forms on top of the melt. At this point the fuel is switched to Bunker C only, and accurate control of its viscosity is maintained by the apparatus. Uniform flame characteristics are thereby achieved which are of great importance for the end product. An article on the technique appears on page 1732 of this issue.

Ultrasonic Inspection and Cleaning

LOS ANGELES, CALIF.—The Met-L-Chek Co., Los Angeles 47, Calif., has applied ultrasonic vibration to their visible penetrant inspection method with startling improvement in speed and effectiveness. The ultrasonic equipment is compact, moderate in price, and simple in operation. It can also be used for general surface cleaning when the ultimate in soil removal is desired for plating, painting, and other processing.

High-speed vibration greatly accelerates penetration, water washing to remove excess penetrant dye, and development of flaw indications. Ultrasonics may make penetrant inspection the No. 1 inspection method for all nonporous surfaces of metal, ceramics, glass, and plastics.

High-density Tape Recording

WASHINGTON, D. C.—J. R. Sorrells of the National Bureau of Standards data processing laboratory has recently developed a method for closely packing digital pulses on magnetic tape. Densities in the range of 500 to 700 pulses/inch can be achieved.

Magnetic tape systems have proved to be too slow in high-speed electronic computers. The Bureau's investigation has been directed toward magnetic tape techniques

5 major advances in a 4 way SOLENOID VALVE

1. **Absolutely tight seating on air or liquids**
2. **Safe, positive operation**
3. **Single or dual Solenoids — for circuit design versatility**
4. **Mountable in any position; operates up to 850 cycles/minute**
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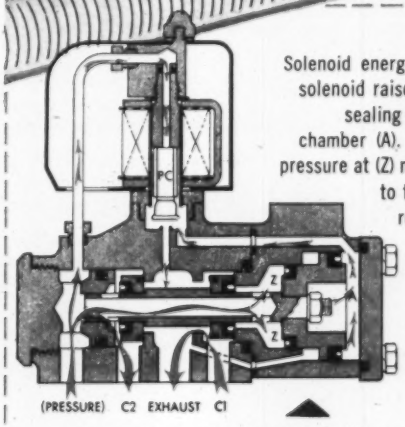
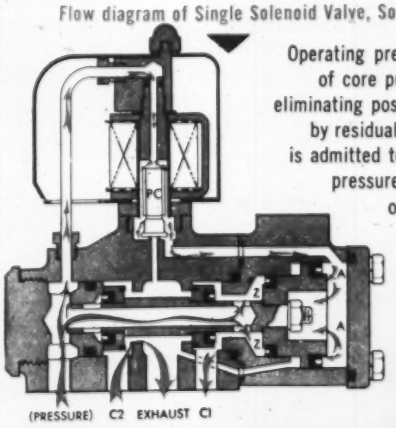


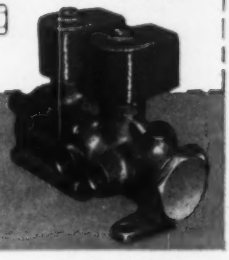
Solenoid energized — energizing the solenoid raises the pilot core (PC) sealing the pressure inlet to chamber (A). (A) is exhausted and pressure at (Z) moves the valve piston to the right. Pressure on resilient inserts forces them against the metallic junction of disc and seat in an absolutely tight seal.

Flow diagram of Single Solenoid Valve, Solenoid Energized

Flow diagram of Single Solenoid Valve, Solenoid De-energized



Operating pressure applied to top of core pushes it off the seat, eliminating possible sticking caused by residual magnetism. Pressure is admitted to (A). While the same pressure exists on both sides of the piston, (A and Z) the area on the right is greater. The resultant force moves the piston to the left.



DUAL SOLENOID VALVE — added safety feature! Locks into position on power failure; coil must be energized for piston movement.

Designed to function perfectly at speeds far in excess of normal requirements, this new 4-way, poppet-type ASCO Valve makes possible a fresh approach to design engineering. It is especially applicable for punch presses, welding machines, machine tools, indexing operations, and air operated clutches and brakes.

1. ABSOLUTELY TIGHT SEATING is assured — with no grinding, lapping or close adjustments. ASCO overcomes the leakage factor that was inherent in the earlier slide valves with a completely new design principle. Valves have been operated for many millions of cycles with no leakage on air!
2. SAFE, POSITIVE OPERATION is provided by the unique pilot action, poppet-type construction and power operation in both directions; piston malfunctioning caused by residual magnetism or binding is eliminated. No return springs are used; fluid pressure alone activates the valve.
3. SINGLE OR DUAL SOLENOID VALVES in 3/8" to 1" pipe sizes.
4. MOUNTABLE IN ANY POSITION, this valve will operate up to 850 cycles/min. Available with standard, water-tight or explosion-proof solenoid enclosures; JIC construction is also provided.
5. SIMPLE IN DESIGN, it has only two moving assemblies — the pilot core and the valve piston. Operating parts are accessible—NO SPECIAL TOOLS ARE NEEDED.

There's one source that solves virtually any solenoid valve problem — ASCO. Have the ASCO Engineer call — or write today for complete data on the Single and Dual Solenoid Bulletin 8344.

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Electromagnetic Contactors
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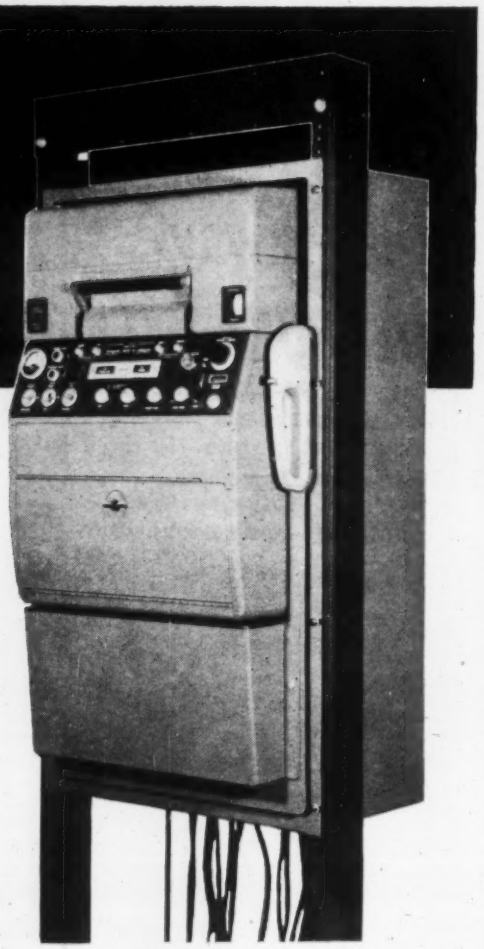
The newest look in vertical, rackmounted oscillographs... 5-119R



Already proved in flight tests, ground-station recording, and engine and rocket test stands, CEC's 5-119 . . . most advanced recording oscillograph available today . . . is now offered for vertical rackmounting.

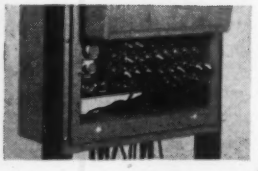
Completely shockmounted, requiring a minimum of space, the 36 or 50-channel 5-119R meets every requirement for both stationary and mobile installations. Its ruggedness has been proved in field tests over the Southwest's roughest terrain. Incorporating more operating conveniences and safety devices than any oscillograph on the market today, it's ideal for instrument trucks and trailers, where space is at a premium . . . effective shockmounting is vital.

Send today for detailed information about the 5-119R, newest version of the world's most versatile recording oscillograph. Ask for Bulletin CEC 1536–X10.

Important note to present 5-119 owners . . . Existing 5-119 Oscillographs can be modified at the factory to 5-119R *vertically mounted* units. Quotations and delivery schedules will be gladly supplied.

Height and Depth . . . Just Right . . . Requires only 33¼" height in standard 19" rack; extends only 13" from rack in full-forward position. Viewing screen visible from normal, standing position.

Easy Loading . . . Push-button controlled handles tilt entire unit forward. Magazine is then detached in just seconds for loading. Reattachment is equally simple.



Convenient Cabling . . . All connectors (including one for each input channel) at front of instrument, providing easy access for cable connection and interchange.

All Adjustments at Front . . . Speed-change gears *freely* reached after magazine is removed. Galvanometer adjustments made and spot positions checked from comfortable, standing position.

And a Vital Extra . . the vertically mounted 5-119R is *effectively* protected against shock and vibration. One set of shock mounts at top and one set at bottom provide *complete* isolation, protect instrument from vibration in any direction.

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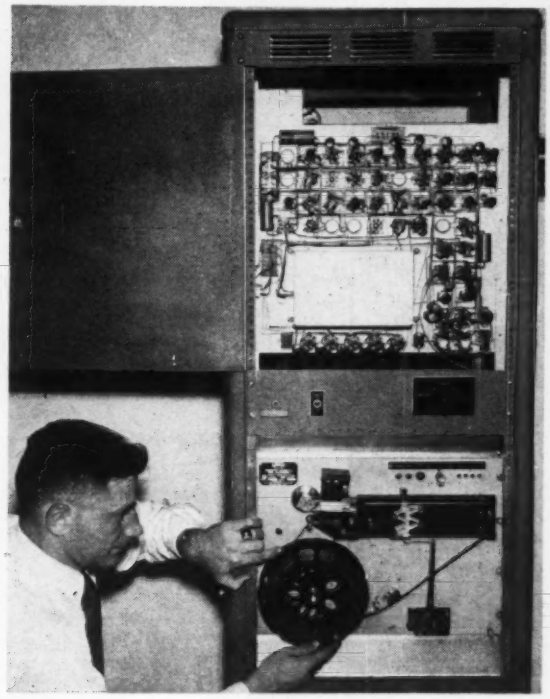

to permit more rapid transmission of information to the computer by increasing the number of digital pulses recorded on each inch of the tape, thereby increasing the over-all efficiency of the machine. Already in operation with the NBS electronic computer (SEAC) are tape-drive units that provide high-speed starting, stopping, and reversing of magnetic tapes, together with maximum practical tape speeds. The novelty of the technique lies in the Bureau's use of a digital pulse technique instead of the continuous current method to achieve NRZ (non-return-to-zero) tape magnetization.

Systems Center for GE

SYRACUSE, N. Y.—General Electric Company has formally opened a new 100-square-foot "Systems Center" for its Heavy Military Electronic Equipment Department. The center will serve as headquarters for the company's development and manufacturing operations on powerful electronic "nerve centers" for military use.

AEC Standards for Protection Against Radiation

WASHINGTON, D. C.—The Atomic Energy Commission has approved a proposed regulation establishing standards for protection of personnel and the public against radiation hazards. Established are maximum permissible limits on exposures to external radiation and concentrations of radioactive material, and maximum permissible levels of radiation in areas access to which is not controlled by the licensee.

Other provisions include requirements regarding personnel monitoring, protective masks and clothing, caution signs and signals, waste disposal, storage of licensed material, instruction of personnel on safe procedures for handling and using licensed material, and records and reports.

news notes from Berkeley division
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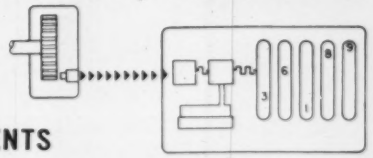

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Books...

INSTRUMENTS and AUTOMATION

Directory of Western Chemical Producers. 1955. Stanford Research Institute, Stanford, Calif. 100 p., unbound. $5. 11 in. Lists products and producers with plants in 11 Western states, Alaska, Hawaii, and three provinces in Western Canada.

Basic Electricity, by Van Valkenburgh, Nooger & Neville, Inc. 5v. [c1954.] John F. Rider, New York 13, N. Y. unbound. $9. 9 in. "Home study course". Taught in "Navy specialty schools" and released for civilian use.

Waterhammer Analysis, by John Parmakian. 1955. Prentice-Hall, New York 11, N. Y. 161 p. $6.50. 9¼ in. Aid in solutions in connection with surge tanks, transient pressures, water columns, wave velocity and reflections, friction losses, air chambers on discharge lines, and allied problems.

Symposium on Odor. [c1954.]. American Society for Testing Materials, Philadelphia 3, Pa. 81 p., unbound. 9 in. (Special Technical Publication, no. 164.) Papers, with discussions, on nomenclature, measurement and control of odors.

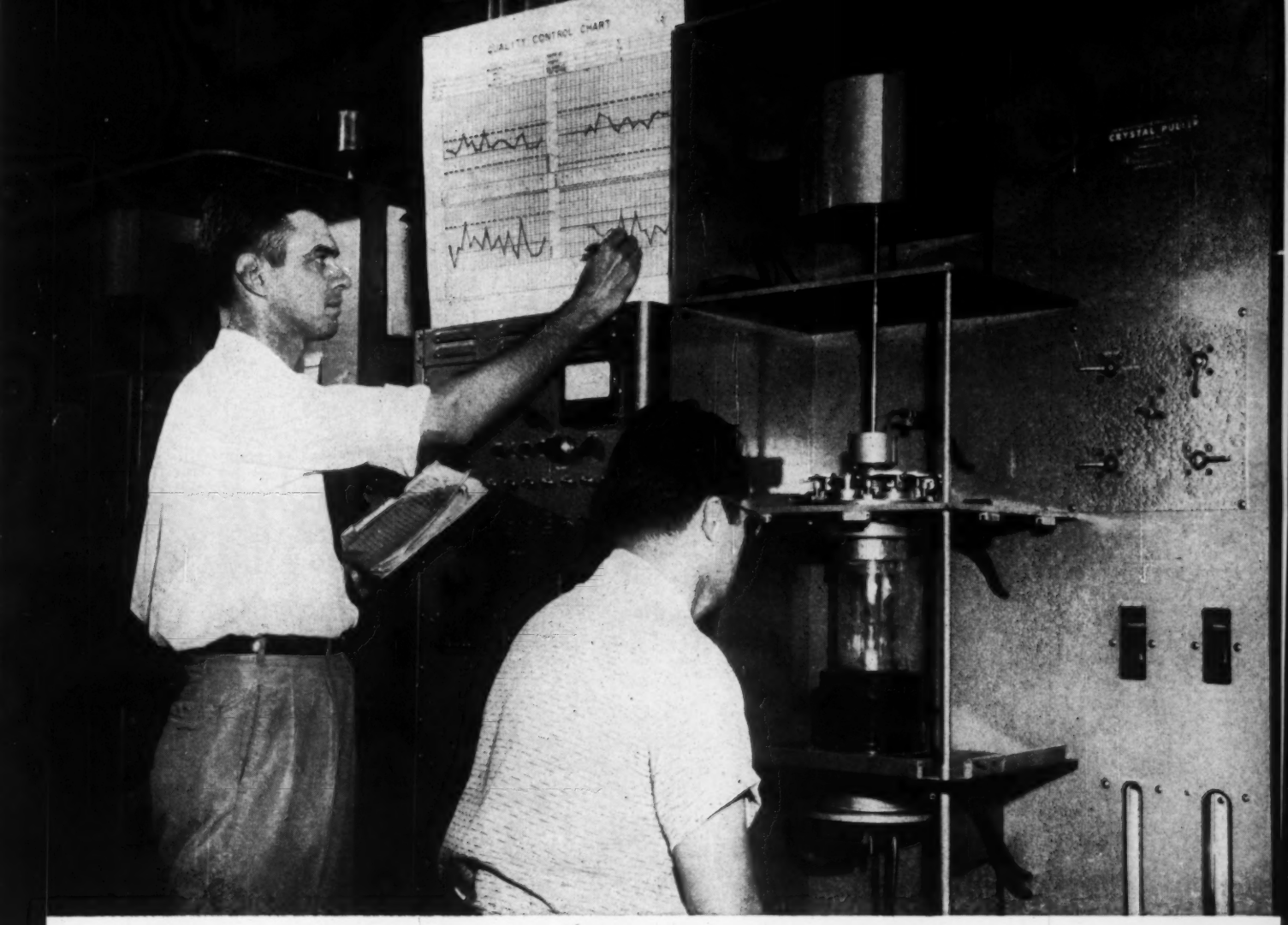
Polarographic Techniques, by Louis Meites. 1955. Interscience Publishers, New York 1, N. Y. 317 p. $6. 9¼ in. Intended as a concise practical and theoretical introduction to polarography, rather than an exhaustive treatment.

Paper Chromatography, by Friedrich Cramer. Ed. 2. 1954, tr. by Leighton Richards. St. Martin's Press, New York 17, N. Y. 124 p. $5. 9 in. A microanalytical separation process. Presents theory briefly, discusses operating methods, and deals in detail with separation of specific substances.

Micro and Semimicromicro Methods, by Nicholas D. Cheronis. 1954. Interscience Publishers, New York 1, N. Y. 628 p. $12. 9¼ in. (Technique of Organic Chemistry, v. 6.) Critical and practical review of the microtechniques of preparative and analytical organic chemistry for advanced workers.

Engineering Analysis; an Introduction to Professional Method, by D. W. Ver Planck and B. R. Teare, Jr. [c1954.] John Wiley & Sons, New York 16, N. Y. 344 p. $6. 9¼ in. Copyrighted by the authors in 1952 as "Engineering Analysis Notes." A course in which learning of new processes and techniques is made subsidiary to the use of old ones in unfamiliar situations.

Applied X-rays, by George L. Clark. Ed. 4. 1955. McGraw-Hill Book Co., New York 36, N. Y. 843 p. $12.50. 9¼ in. In this edition, "Almost all of the new material has been derived directly from original papers—It is the privilege of the author to cover for *Chemical Abstracts* all the medical radiological journals published in the world, and this has provided much of the new information included in the chapter on biological effects." *Preface.*



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This close parameter control has enabled Texas Instruments to pace the industry in transistor development and application. Newest TI germanium devices are n-p-n high speed switching transistors. An important step toward complete transistorization of computers, these grown junction units have beta spreads of two-to-one and are 100 per cent tested for switching characteristics. TI was also first to produce silicon transistors commercially, and *only* TI manufactures germanium transistors for *all* three transistorized pocket radios now on the consumer market. For radio, general purpose, and many specific applications, Texas Instruments manufactures both p-n-p alloyed junction and n-p-n grown junction germanium types.

For your own transistorized product development, specify the exact devices you need from TI's wide range of semiconductor products — germanium and silicon; p-n-p or n-p-n types; diodes, triodes, tetrodes. Write for new descriptive data and curves that will help simplify your production problems.

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- ☐ P-N-P alloyed junction general purpose transistors
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- ☐ Phototransistors
- ☐ Grown junction tetrodes

SILICON

- ☐ General purpose transistors
- ☐ Power transistors
- ☐ Junction diodes
- ☐ Voltage reference diodes

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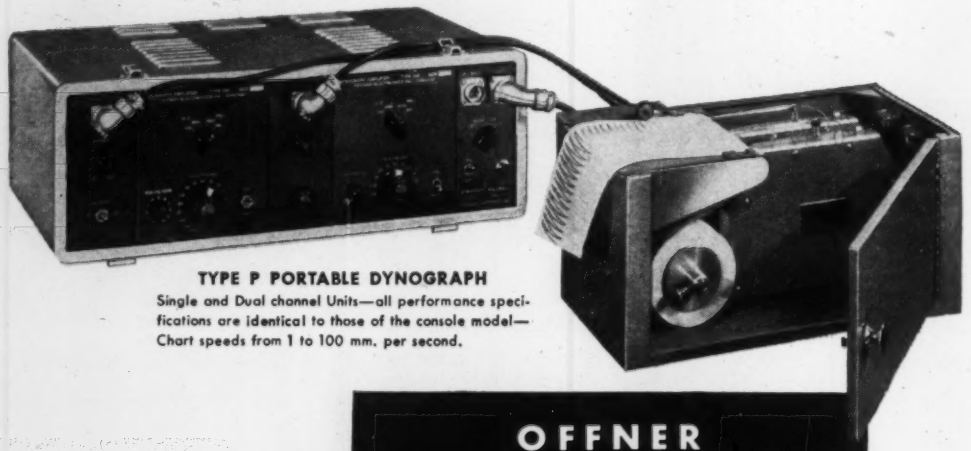

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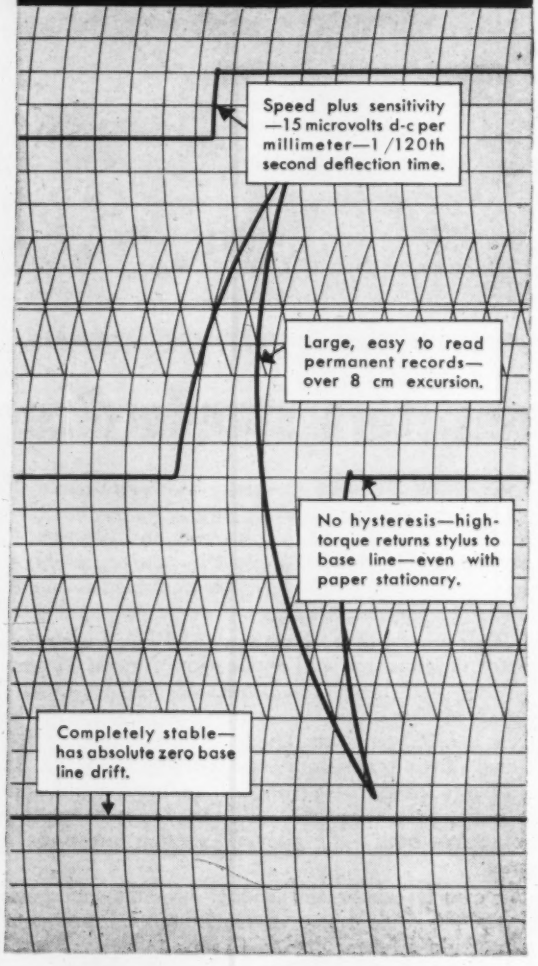
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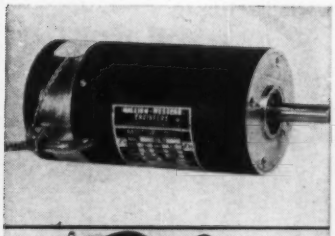
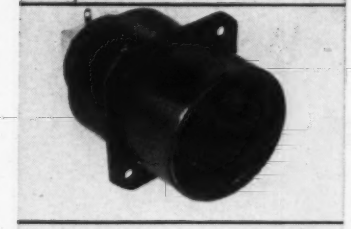
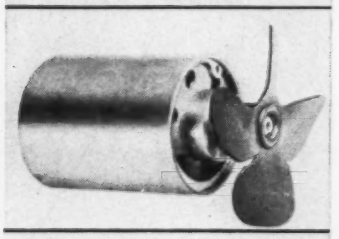
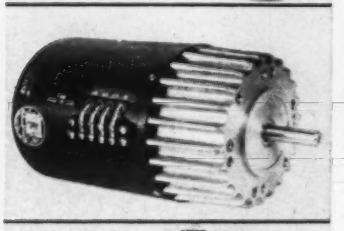
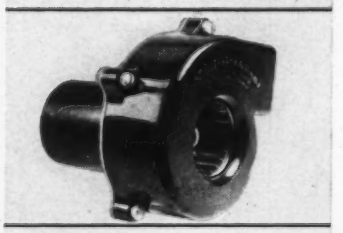
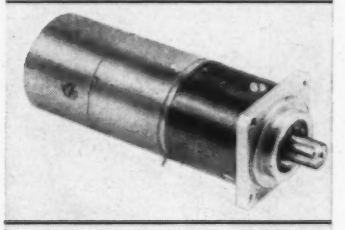
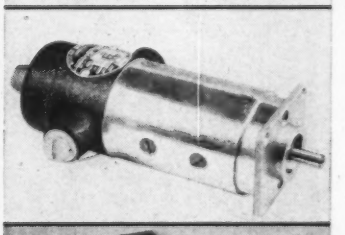
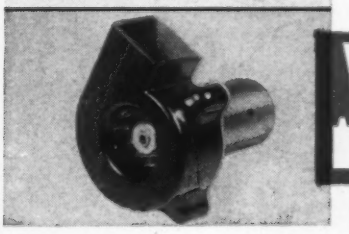

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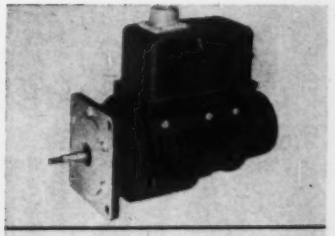
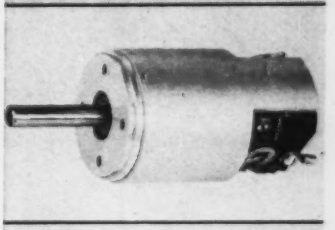
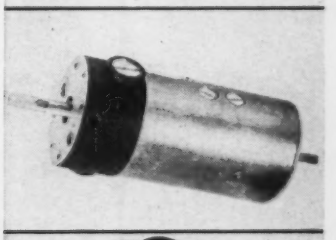
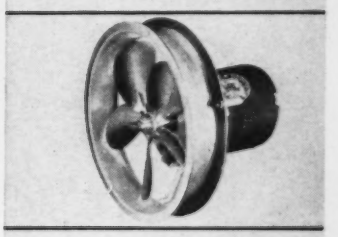
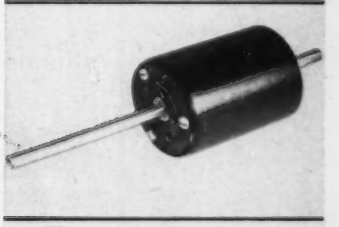
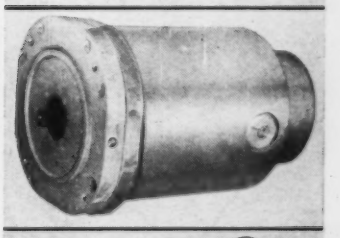
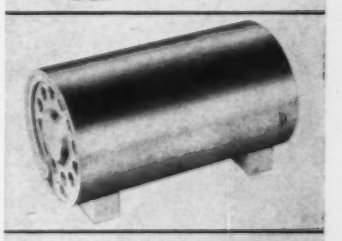
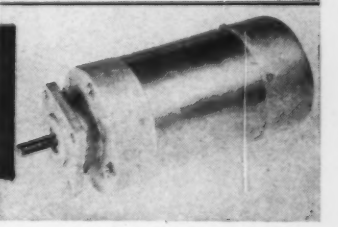









"The difference is reliability" ★ *Since 1888* 5568

WESTERN GEAR

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

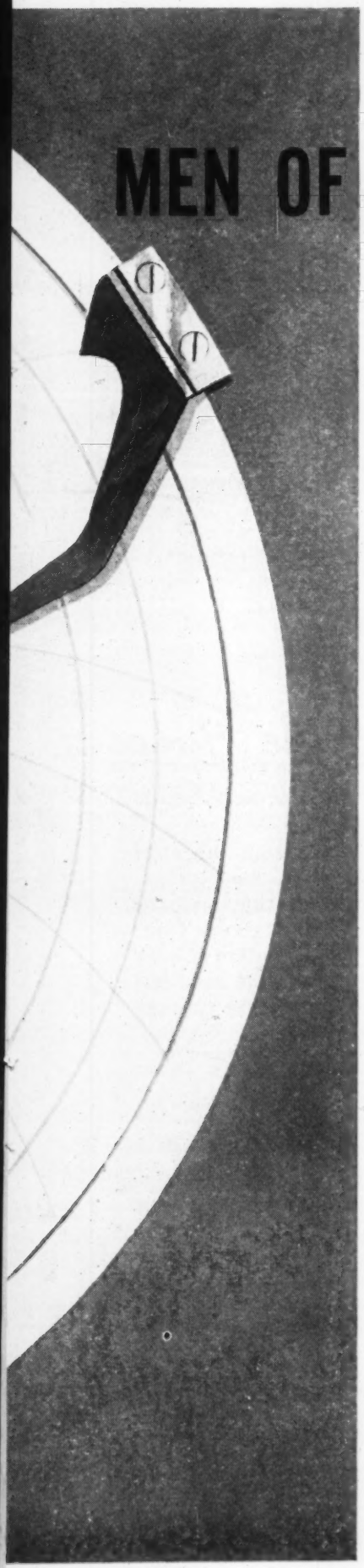
PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **37** on inquiry card.

The makers of

TELECHRON MOTORS SALUTE THE

For more information circle **38** on inquiry card.



MEN OF AUTOMATION

. . . builders of the precision instruments that make automatic controls possible

Whether it's recording instruments, automatic controls, electronic digital computers (or the globe-girdling satellites to come), progress follows the fine precision instruments your ingenuity and ability make possible.

We are proud to be a part of this progress . . . proud that Telechron timing motors are the heart of countless precision instruments you have designed for an almost infinite variety of purposes.

Today as always, you can call on us for complete engineering application assistance . . . confident that your use of Telechron fully synchronous timing motors assures accurate performance, long life and low cost. For details of this service, write Telechron Motors, Clock and Timer Dept., General Electric Co., Ashland, Mass.

TELECHRON

MARK OF TIMING LEADERSHIP

For more information circle **38** on inquiry card.

CABLED TUBES

for INSTRUMENTS & CONTROLS

Cut-away View Shows How

CRESCENT ARMORED MULTITUBE

Bends

Without Distortion of the Tubes

Because They Are Twisted Together in a Long Spiral.

The tubes are thoroughly protected from injury during and after installation by a flexible interlocked galvanized steel armor, TYPE CA, or corrosion resistant polyvinyl chloride thermoplastic sheath, TYPE CT, or combination of both. One tube in each layer has a bright blue color which permits a ready identification of each tube at both ends. This is a real time saving feature as the installers can connect both ends without the necessity for tracing through each tube.

CRESCENT MULTITUBE is available with 2 to 19 copper tubes, ¼" O. D., in continuous lengths up to 1000 feet. Also furnished in aluminum, steel or polyethylene tubes, and 5/16", ⅜" and ½" O. D. sizes.

Substantial savings can be made in installed cost on moderate to long runs with better protected installation of instrument tubing. This product is licensed under U. S. Patent 2,578,280.

Send for Bulletin Giving Complete Information and Engineering Data

CRESCENT

INSULATED WIRE & CABLE CO.

OLDEN & TAYLOR STS., TRENTON, NEW JERSEY

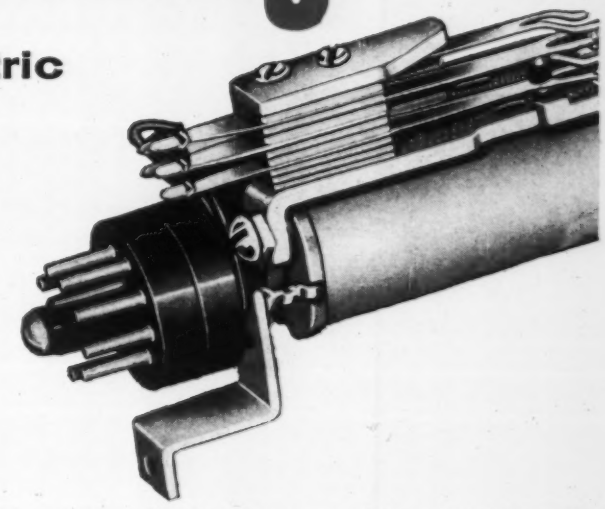
For more information circle **39** on inquiry card.

you can have the advantages of

plug mounting

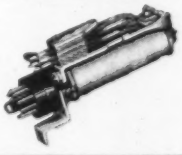
in all these Automatic Electric

relays

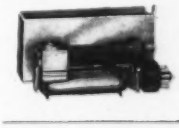


CLASS A:
The "all-purpose" relay for use where first cost is important. Gives long, dependable service. Size: 4⅜" x 2³⁄₁₆" x 1⁷⁄₁₆".

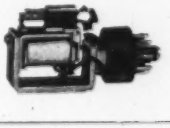
CLASS B:
Made for extremes of long service life and dependability — often exceeding 400 million operations! Size: 4⅜" x 2³⁄₁₆" x 1¼".



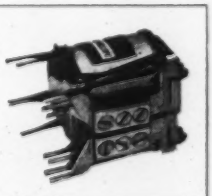
CLASS F:
Low operating power makes this relay especially desirable in a.c. circuits where relays function without specified operate or release time delays. Size: 4⅜" x 1¹³⁄₁₆" x 1¼".



CLASS S:
Made for exacting miniature requirements. Used in aircraft where resistance to shock and vibration is needed in a small, light, reliable relay. (For printed circuit applications—see below.) Size: 2⁹⁄₁₆" x 2" x 1¼".



CLASS Z:
Provides maximum timing in a "small-as-possible," low-cost relay. Compact, light, resistant to shock and vibration. Size: 3¼" x 2⅞" x 1¹³⁄₃₂".



"PLUG-IN" RELAY FOR PRINTED CIRCUITS.
Design of coil and spring terminals permits direct insertion into printed circuits with high-conductance connections, easily soldered. Bearing design gives up to 120 million operations without readjustment or relubrication. Size: 1¾" x 1⁵⁄₁₆"-1¾" (depending upon number of contact springs) x 1".

For any application, you can choose an Automatic Electric relay—a top-quality relay in every way—with the additional advantages of *plug mounting:*

Minimized inventory—When you standardize on plug-in relays, you can often interchange the same basic relay in many models of your equipment. Thus, you make substantial savings by reducing your inventory costs, speeding assembly.

Fast, simplified inspection and maintenance—Plug-in relays permit periodic bench inspections with almost no "down time" involved. Entire banks of relays can be removed for testing, and then replaced, in *seconds.*

Simplified replacement—Plug-mounted relays can be replaced quickly and easily at otherwise inaccessible points in your equipment. Even an unskilled service man can replace relays in a matter of seconds without tampering with circuit wiring.

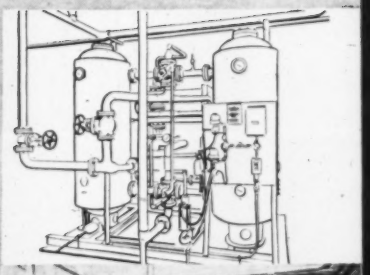
You can select Automatic Electric plug-in relays from five basic types and thousands of individual assemblies.

Send for Relay Circulars 1800—1804—They give complete specifications, dimensional drawings, and helpful information. *Address* Automatic Electric Sales Corporation, 1033 West Van Buren Street, (HAymarket 1-4300) Chicago 7, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

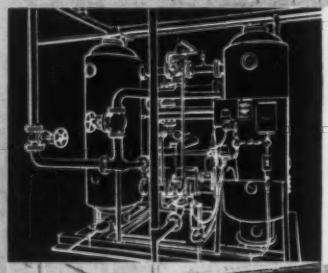
RELAYS SWITCHES
AUTOMATIC ELECTRIC
ORIGINATORS OF THE AUTOMATIC DIAL TELEPHONE
CHICAGO

For more information circle **40** on inquiry card.

10 REASONS WHY THE PRITCHARD HYDRYER IS THE ANSWER FOR INSTRUMENT AIR DRYING

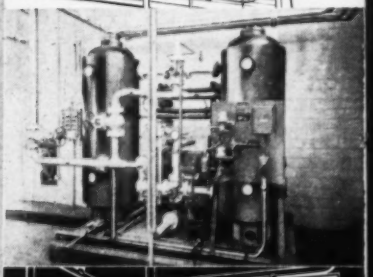


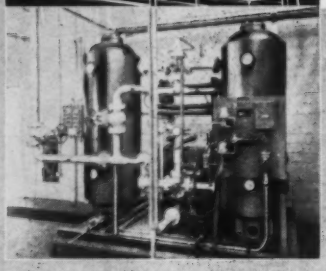
1. NO WASTE. 100% of all gas entering the HYDRYER is dried without loss.



2. FULL LINE PRESSURE REACTIVATION. Pressuring and de-pressuring of adsorbers between cycles is eliminated.

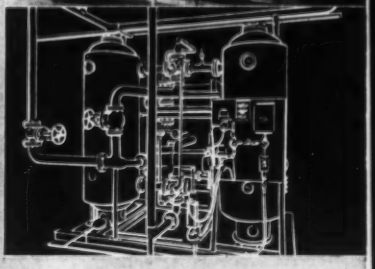
3. PURGING ELIMINATED. The Type A HYDRYER uses the inlet main gas stream for reactivation, not an external stream of atmospheric air or other gas.





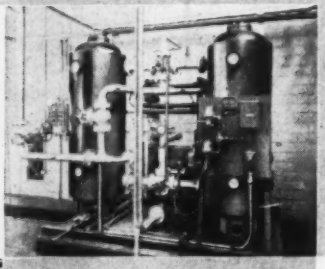
4. LONGER ADSORBENT LIFE. Dusting and breakage of particles is reduced because there is no movement of adsorbent due to pressure changes or high velocities.

5. REACTIVATION GAS IS PREHEATED. This assures complete heat transfer during the heating period for uniform reactivation of the adsorbent.



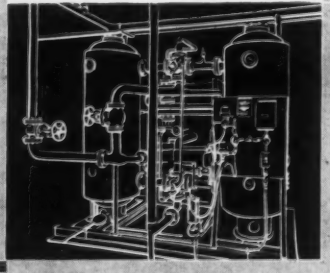
6. NO MOVING PARTS. No operating or maintenance costs on blowers, motors, fans, rotating beds . . . because there are none.

7. SIMPLIFIED OPERATIONS. The process is greatly simplified, requires minimum of operations. Important, when you have inexperienced operators.

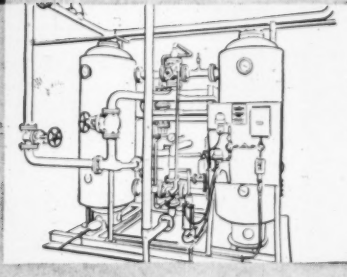


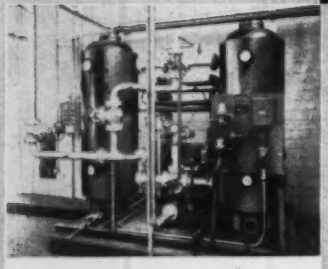
8. REDUCED EQUIPMENT AND LINE SIZES. Equipment and line sizes are small compared to those required for reactivation at atmospheric or lower pressures.

9. SAFETY FACTORS MINIMIZE HUMAN ERROR. No equipment can be damaged by opening the wrong valve.



10. VISUAL OBSERVATION and check of the moisture adsorbed from the gas stream is possible on each cycle.





HYDRYER ON DUTY, drying instrument air at the Farmers Union Exchange Refinery, Laurel, Montana. It dries 400 SCF/M of air at 60 psig and 80-95°F. saturated. Outlet gas dew point is —40°F.

SEND FOR BULLETIN

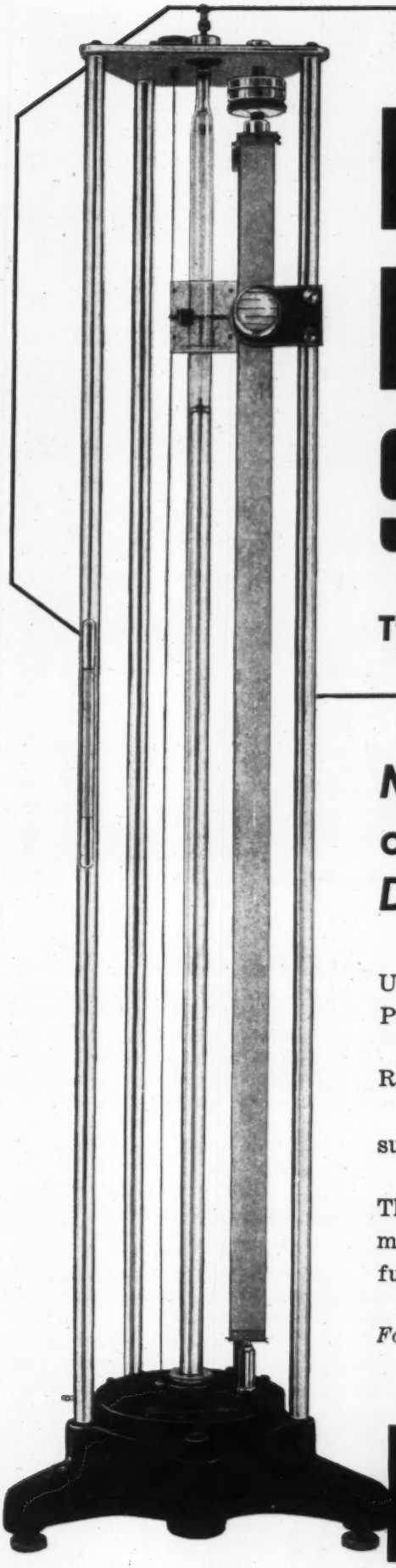
You can learn about the many ways HYDRYERS may be used to dry instrument air from this Pritchard bulletin, No. 16.0.181. Send for your complimentary copy today on your company letterhead.

INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
AIR COOLED HEAT EXCHANGERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 448, 4625 Roanoke Parkway, Kansas City 12, Mo.



MERCURIAL-PRECISION STANDARD

Type FA-187

Measures *Absolute* or *Differential Pressure*

Used interchangeably as a Barometer or Differential Pressure Manometer.

Range: 0 to 800 mm of Hg.
0 to 31.5 in Hg. or in any other desired pressure unit of equivalent range.

The magnetic vernier reads to 0.01 mm or 0.005 in. of mercury with an accuracy of 1 part in 5000 over the full range.

For additional information,
write for Publication Number TP-32-A.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST., BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

A-103

For more information circle **42** on inquiry card.

← circle **41** on inquiry card.

The ancient priests of Egypt were engineers whose great pyramid of Cheops was sextant, compass and slide rule—all in one. From sighting the Pole Star, to squaring the compass, to the mathematics of pi—it's all there in the pyramid of Gizeh.

flying pyramids

Wonder of the world for ages, Gizeh's pyramid was a fount of mathematical data—a tool to check measures, an aid to celestial navigation. Today's aircraft are "flying pyramids"—collecting and integrating instantaneous measurements for orientation and control. Kollsman activities cover these seven fields:

AIRCRAFT INSTRUMENTS
PRECISION CONTROLS
PRECISION COMPUTERS AND COMPONENTS
OPTICAL COMPONENTS AND SYSTEMS
RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT
MOTORS AND SYNCHROS
INSTRUMENTS FOR SIMULATED FLIGHT TRAINERS

Our manufacturing and research facilities . . . our skills and talents, are available to those seeking solutions to instrumentation and control problems.

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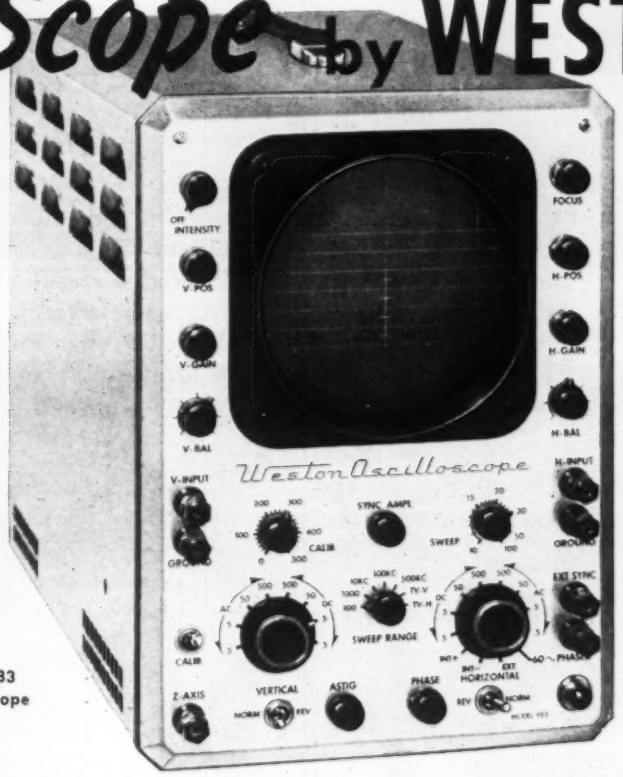
80-22 45th AVE., ELMHURST, N. Y. • GLENDALE, CALIF. • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

For more information circle **43** on inquiry card.

NOW...the All-purpose 'Scope by WESTON



Weston
Model 983
Oscilloscope

Model 983 is a high gain, wideband Oscilloscope designed to accurately reproduce waveforms comprising a wide band of frequencies. High sensitivity of 15 millivolts per inch RMS makes this "scope ideal for—SETTING RESONANT TRAPS...SIGNAL TRACING IN LOW LEVEL STAGES...AS A GENERAL NULL INDICATOR...for PHASE CHARACTERISTIC MEASUREMENT IN INDUSTRIAL APPLICATIONS...and for SWEEP FREQUENCY VISUAL ANALYSIS.

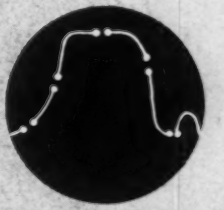
The 'scope contains identical vertical and horizontal push-pull amplifiers with a choice of AC or DC coupling without affecting either sensitivity or band width. Both amplifiers have compensated step attenuators and cathode follower input. *It has excellent square wave reproduction with overshoot of only 2 to 5%, with a rise time of 0.1 microsecond. The 'scope response is essentially flat throughout the specified range of 4.5 mc and is usable to 6 mc.*

The unit has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals is easily accomplished by means of toggle switching. *Tube replacements are non critical, and etched circuitry facilitates quick and rapid maintenance.*

The Model 983 Oscilloscope is now available through local distributors. For complete literature write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

WAVEFORM ANALYSIS

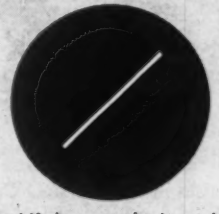


Response curves accurately displayed. Ideal for use with Weston intensity marker display. A fast, retrace sweep circuit with cathode follower output prevents pattern distortion.

SQUARE WAVE RESPONSE

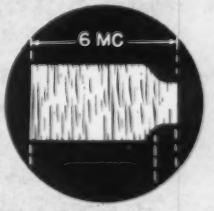
Overshoot is only 2 to 5%. Rise Time is 0.1 Microsecond. Square wave depicted 250 kc.

PHASE MEASUREMENTS



Phase shift between horizontal-vertical amplifiers, 0-500 kc-0°, to 1 mc within 2°; by internal adjustment with gain controls at max 0° phase shift possible on any specific frequency to 6 mc.

RESPONSE CHARACTERISTIC

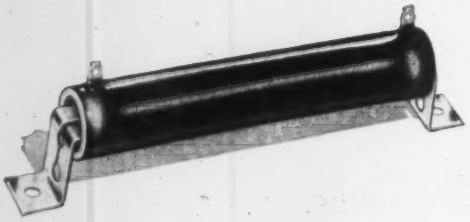


Note flatness throughout specified range; to 3.6 mc down 1.5 db, at 4.5 mc down 3 db, at 6 mc down 6 db.

For more information circle **44** on inquiry card.

For Dependability in Critical Circuits...

Specify MALLORY Resistors

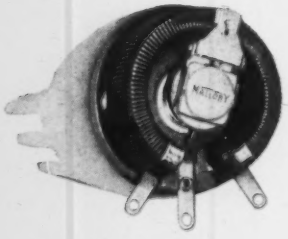


Vitreous Enamel Resistors

For use as dropping resistors, voltage dividers, etc., Mallory vitreous enamel resistors are rated for continuous duty at ambient temperature of 65°C. Long service and excellent stability are the results of using highest quality ceramic core, wire and enamel coating. Fixed and adjustable in ratings from 5 to 200 watts.

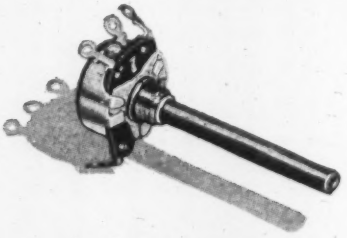
TO meet the increasingly stringent demands of modern instrument circuits, Mallory offers an extensive line of top-quality fixed and variable resistors. Used for years by leading manufacturers of electronic equipment, these components can be relied upon for stability, precision and long service life to meet your most exacting specifications . . . at economical cost.

In addition to the standard lines of resistors shown here, Mallory supplies a number of types of adjustable wire-wound resistors, and high power rheostats. For technical information on any of these, and for engineering assistance in their use in your own circuits, write or call Mallory today.



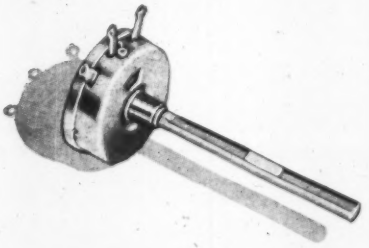
Power Rheostats

Especially useful in instrument circuits is the Mallory 25-watt rheostat. Exclusive hinged contact arm permits inspection or cleaning of brushes without changing contact pressure. Tapered windings are produced by a special variable pitch winding method that eliminates welded joints and hot spots. Other ratings up to 500 watts are available.



Variable Carbon Controls

Only $1\frac{5}{16}$" in diameter, these carbon controls fit readily into crowded chassis layouts. A special Mallory process produces resistance elements with high stability and minimum drift under adverse climatic conditions. Electrical noise is exceptionally low. Available in a complete range of tapers and resistance values, in both single and dual types.



Wire-Wound Controls

Famous for long service and superior performance, Mallory wire-wound controls cover the range from 2 to 7 watts, in resistances from $\frac{1}{2}$ to 150,000 ohms. Single, dual and triple sections and "T", "H" and "L" pad attenuators are available, with linear or special tapers.

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

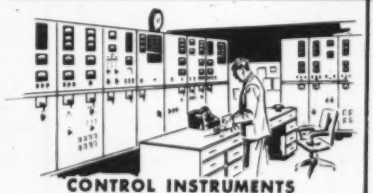
Expect more . . . Get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For more information circle **45** on inquiry card.

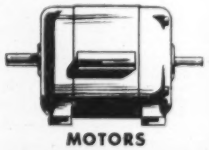
TESTING

COMMUNICATIONS

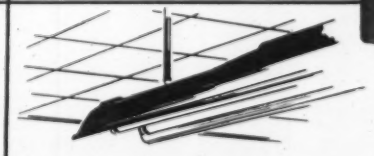


CONTROL INSTRUMENTS

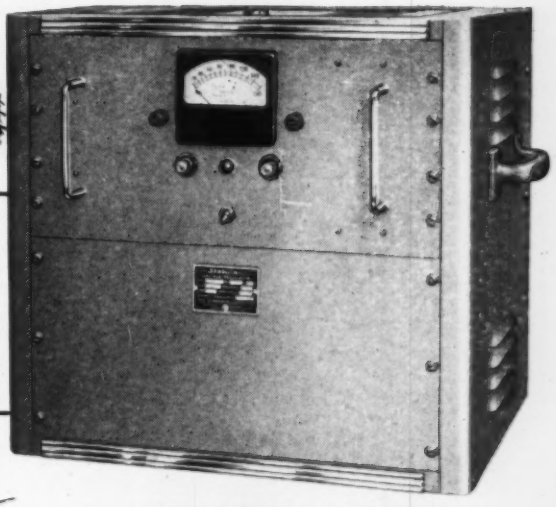
INSPECTION



MOTORS



LIGHTING



ELECTROMECHANICAL (TYPE EM)

For large industrial loads and for applications requiring zero wave form distortion or high efficiency.

STABILINE AUTOMATIC VOLTAGE REGULATORS TYPE EM

Get Zero Wave Form Distortion – with Precise Root Mean Square Voltage Control

When you use *heat, light, sound, power* or *electronic gear*, you need to control voltage to closer limits than it is available commercially.

In thousands of installations the STABILINE Automatic Voltage Regulator type EM has proved itself a rugged "work horse" and an accurate means of maintaining *root mean square* voltage — the rating for which all electrical equipment is designed. Its zero wave form distortion makes it a "must" for many types of electronic equipment. Its efficiency is comparable to fixed-ratio transformers.

STABILINES type EM are available in 115, 230 and 460 ratings for single and three phase duty in capacities up to 100 KVA with correction speeds from .075 to .32 seconds per volt. Send for bulletin for full details.

See Superior Electric's Mobile Display when it is in your area.

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Position .....

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Company Address .....

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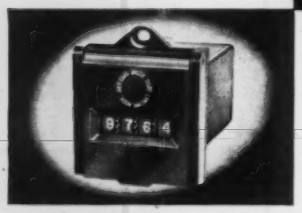
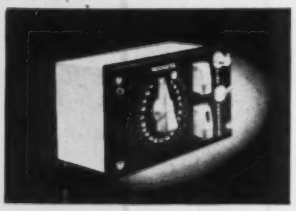
For more information circle **46** on inquiry card.

ACCURACY

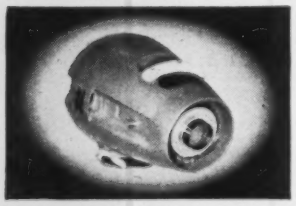
IN MILLISECOND TIMING



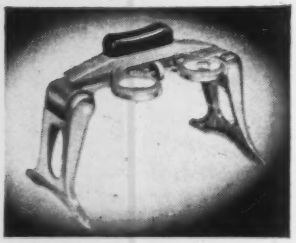
Magnetic counters . . . Miniature 3 and 4 digit. For DC voltages from 6 to 110



Programming devices . . . Automatic electronic and electro-mechanical Rocket fire intervalometers



Cameras . . . Radar recording, Aerial Reconnaissance and Special Purpose



Photogrammetric . . . Instruments, Optical Devices, Stereo Viewers, Height Finders

ABRAMS
INTERVALOMETERS

SELECTIVE REPETITIVE TIME INTERVALS

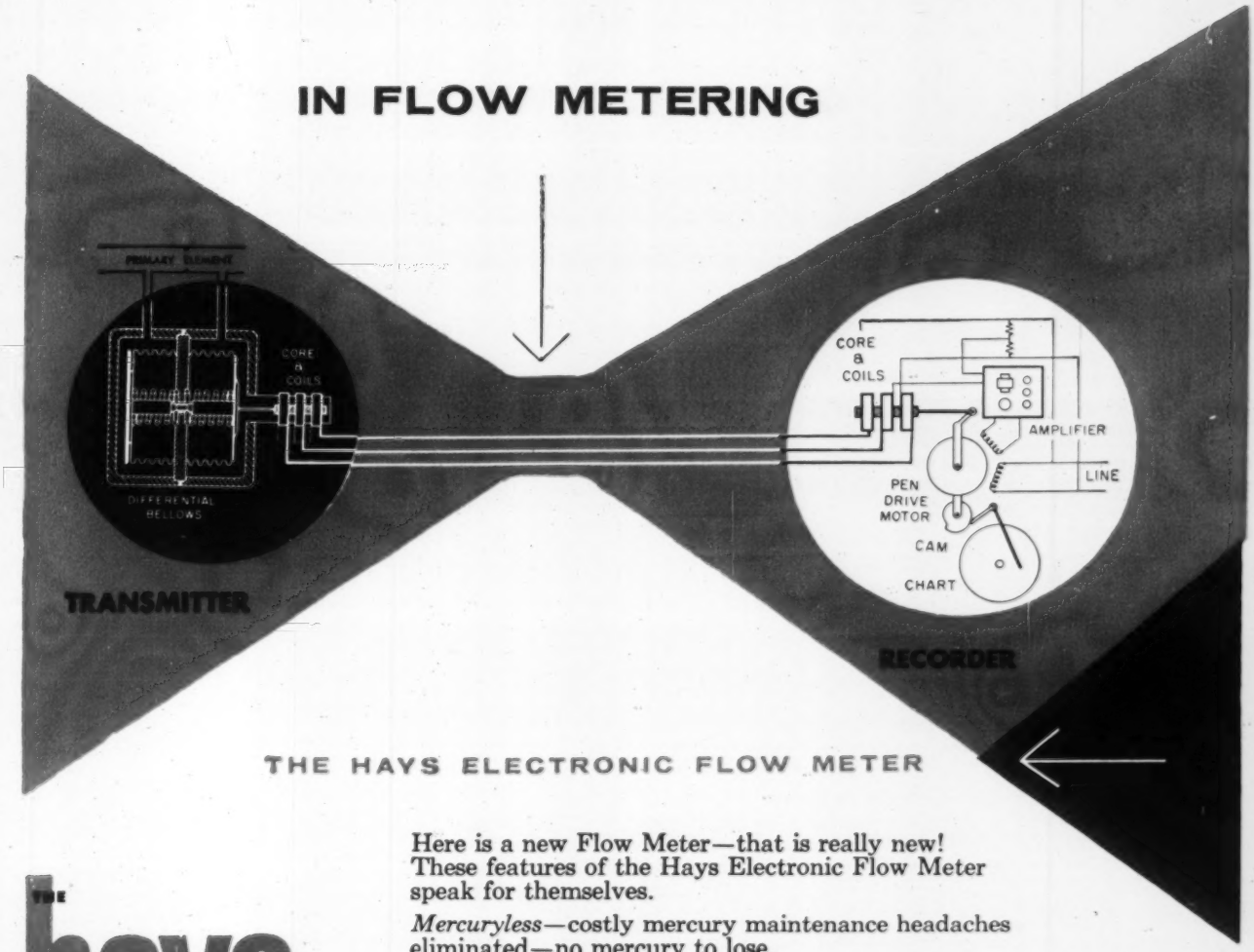
- IN STEPS OF 50 - 100 - 200 - 500 - 1000 MILLISECONDS
- IN RANGES OF .5 TO 12 — 1 TO 24 — .5 TO 60 — 1 TO 120 SECONDS
- REPEATED ACCURACY OF 1% MAXIMUM ERROR

ABRAMS
INSTRUMENT CORP.
LANSING, MICHIGAN, U.S.A.

For more information circle **47** on inquiry card.

new dimensions

IN FLOW METERING



THE HAYS ELECTRONIC FLOW METER

THE **hays** CORPORATION

MICHIGAN CITY 8, INDIANA

Automatic Combustion Control • Veriflow Meters and Veritrol • Electronic Oxygen Recorders • CO_2 Recorders Boiler Panels • Gas Analyzers • Combustion Test Sets Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

Here is a new Flow Meter—that is really new! These features of the Hays Electronic Flow Meter speak for themselves.

Mercuryless—costly mercury maintenance headaches eliminated—no mercury to lose.

Rupture-proof Bellows—provide positive protection against over-range.

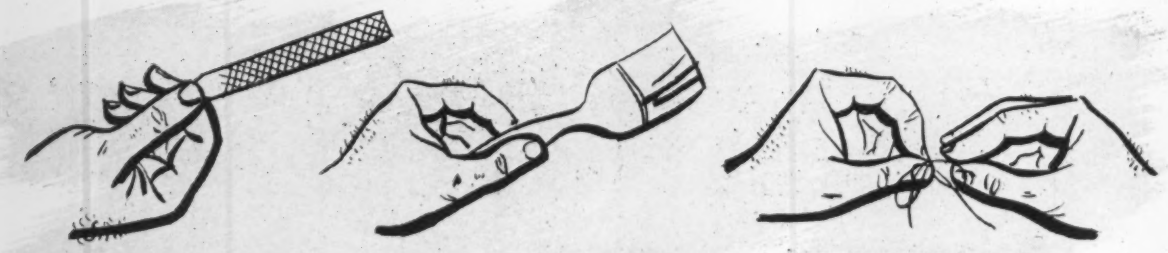
Continuous integration—motor-driven continuous mechanical integrator is extremely accurate even on rapid load changes.

Electronic operation—requires only 4 seconds for full scale pen travel with accuracy of ¼% of full scale differential.

Other features include null-balance transmission, powerful motor, easy readability, accuracy unaffected by normal temperature changes. Explosion proof transmitters and wide range meters also available.

For complete information, write for Bulletin 54-1074-222.

For more information circle **48** on inquiry card.



NO FILED NOTCHES **NO PAINT DAUBS** **NO STRING TYING**

HANCOCK

"FLOCONTROL" VALVES GIVE YOU PIN/POINT CONTROL

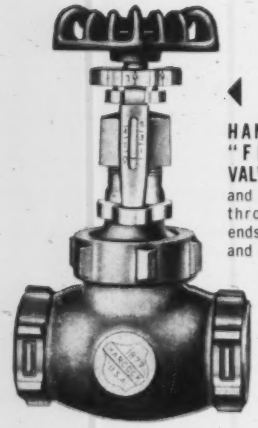
Here's manual control of flow, temperature and pressure that's really precise. Hancock "Flocontrol" Valves, with micrometer dial and pointer mounted on the bonnet, permit settings to within 1/100th turn of the handwheel! Equally important, any setting can be duplicated easily, perfectly – any time.

Hancock "Flocontrol" "3 in 1" design gives you the advantages of a variable orifice, plus a shut-off, plus an index... all in "one package." Bronze and steel types are available. Both have a scientifically designed V-Port valve disc that *compels proportional flow throughout the entire lift of the valve stem.* The shut-off seating surface is entirely removed and separate from the controlling V-Ports. Super-finished "500 Brinell" stainless steel seats and discs minimize the effects of wire-drawing and steam cutting.

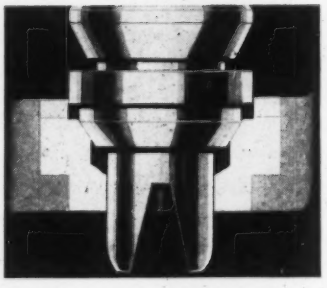
For fine throttling control and proportional flow... for greatest efficiency, lowest operating costs – install strong, dependable Hancock "Flocontrol" Valves in your lines.

YOUR LOCAL INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your nearest telephone. His 24-hour emergency service and large stocks of the finest supply items simplify your purchasing and save money for you.

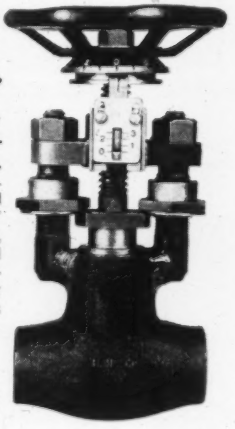
When Hancocks go in, valve costs go down



HANCOCK BRONZE "FLOCONTROL" VALVES. **Types:** Globe and Angle. **Sizes:** ¼" through 2". Screwed ends. Available in 150# and 300# Series.



VALVE SEAT AND V-PORT DISC fully closed. As the valve is opened proportional flow is gradually increased. The Hancock "Flocontrol" Valve has straight-line flow. Its regulation does not depend on the short-wearing, fine threads common to a needle valve.



HANCOCK 600# STEEL "FLOCONTROL" WELDVALVES. **Types:** Globe and Angle. Outside Screw and Yoke. **Sizes:** ¼" through 4". Screwed, Socket Welding and Flanged Ends. Available with 150#, 300# and 600# Series Flanges.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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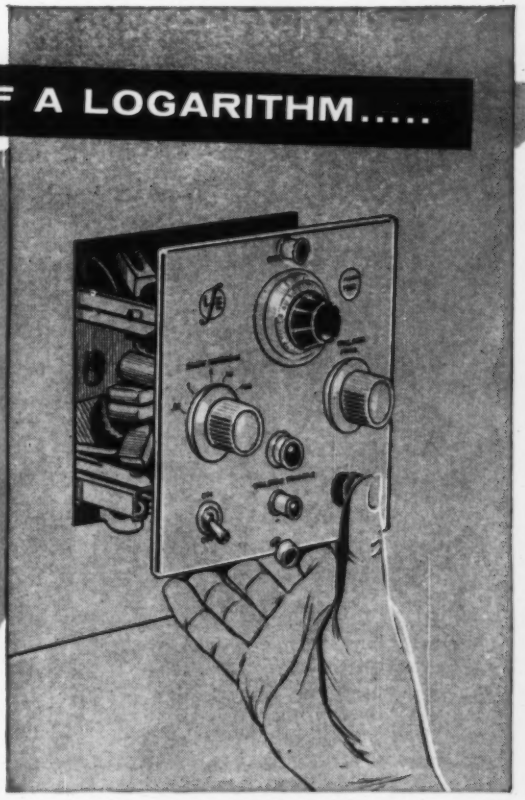
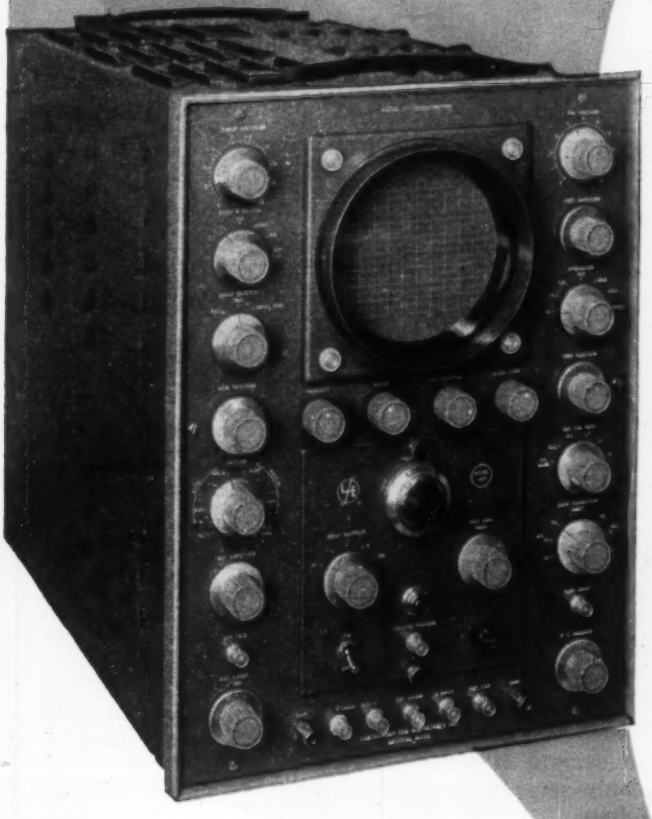
AS EASY AS ROLLING OFF A LOGARITHM.....

LFE'S *easy-SIX*→ 411 OSCILLOSCOPE





We're frankly throwing out our chests.

In the 411 Oscilloscope we've come up with a Jack-of-all-trades that's master of every one! That's why we call it the "Easy-Six". This high-accuracy scope is so *easy* to operate, yet it features *six* X-axis plug-in units and all the bandwidth and sensitivity needed for advanced electronic research.

We're pleased as Punch to have engineered such a terrific scope, and we know you'll be just as pleased to use it. Here are some of the ingenious features of the "Easy-Six" that have put satisfied smiles on our customers' faces.

- **TRIGGER** — Only two controls needed — trigger selector and trigger amplitude.
- **DELAY**—One switch only. Simply turn sweep selector switch to delay. No additional cables necessary.
- **SWEEP SPEEDS** — No more than two controls needed to vary Sweep Speed. Direct-reading, incrementally variable Sweep Ranges, whose accuracy is maintained uniformly, avoid ambiguity and interpolations.
- **DELAY SYSTEM** — Delay control is calibrated *directly* in microseconds of delay. Same trigger for the delay as for the undelayed sweep.
- **VOLTAGE CALIBRATOR** — May be operated simply by turning the signal calibrator switch.

For specifications and more details about the "Easy-Six", write for our informative, free bulletin and the name of the LFE Engineering Representative nearest you.

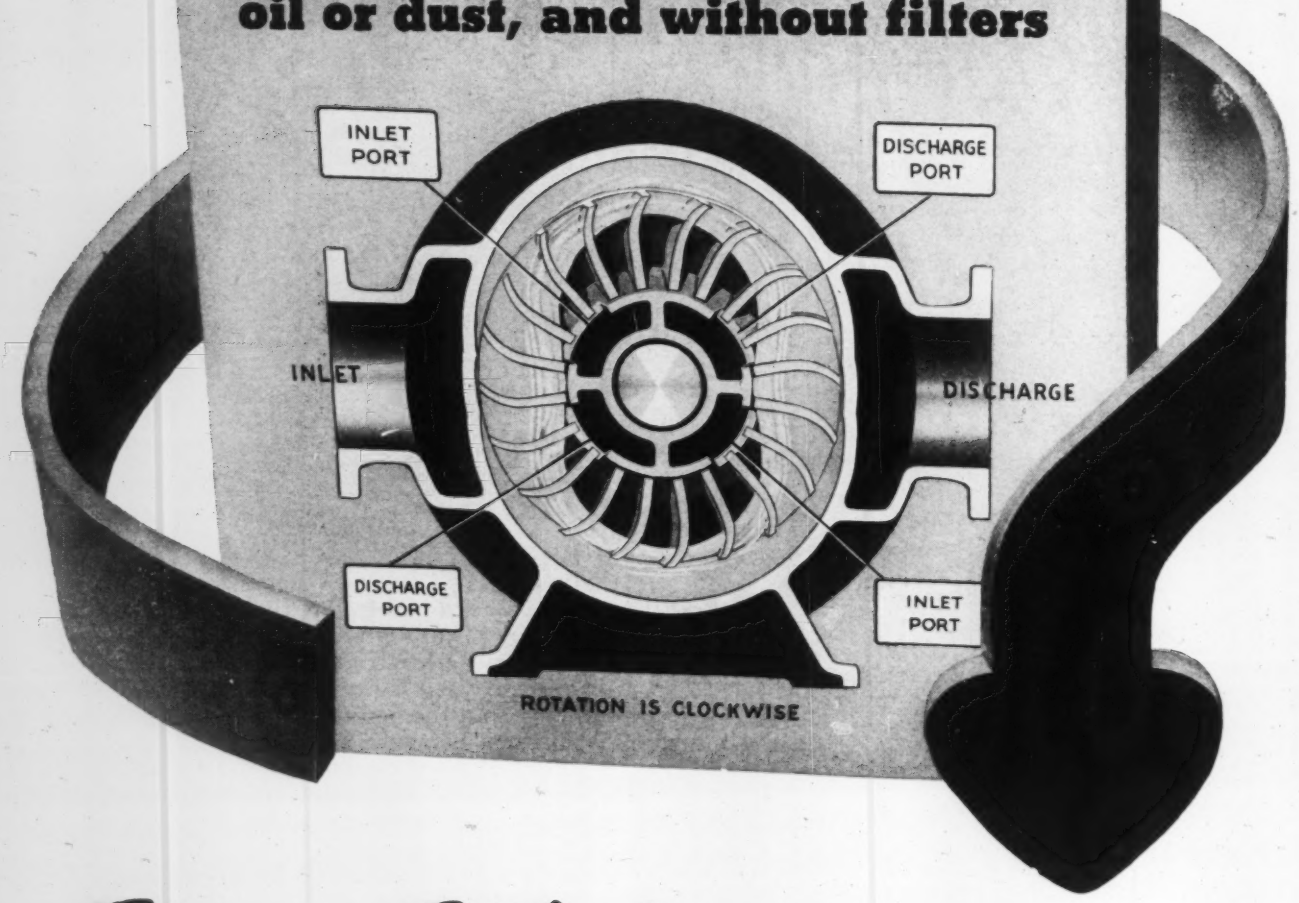
L/E®

LABORATORY FOR ELECTRONICS, INC.

75 Pitts Street, Boston 14, Mass.

For more information circle **50** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



Here is Why!

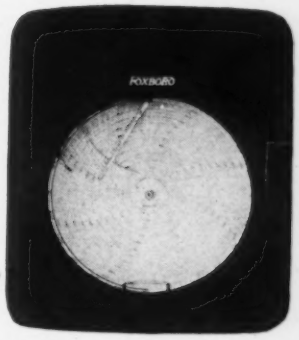
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

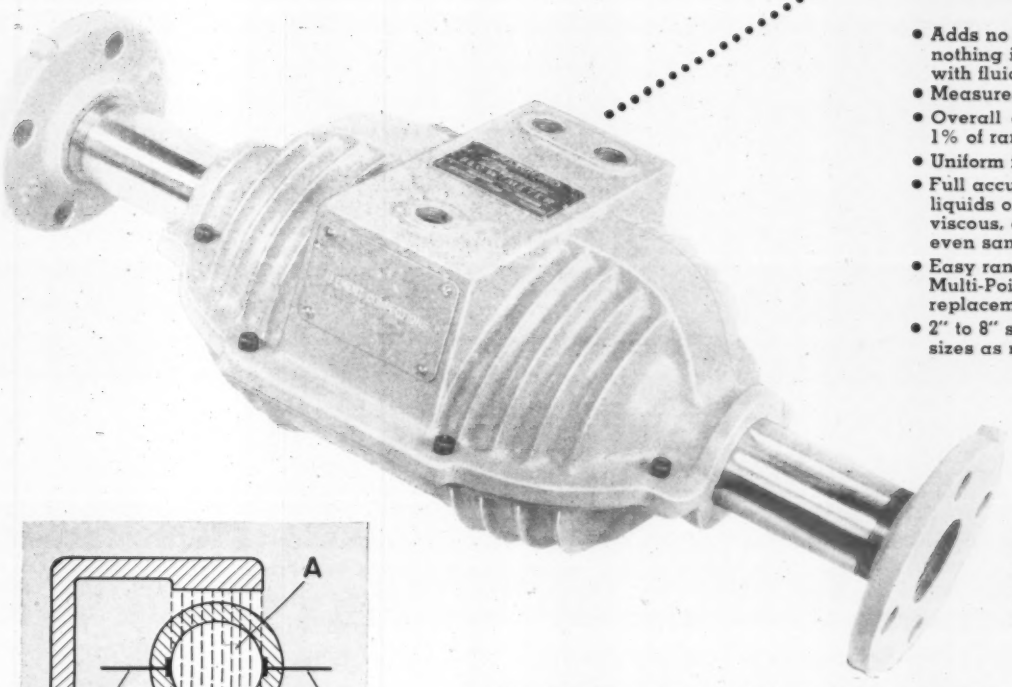
®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

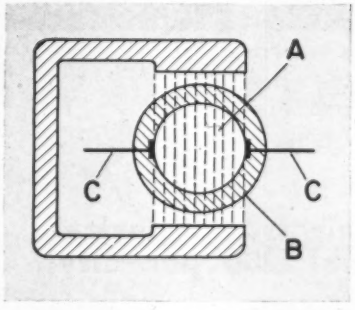
NEW! a flow meter with no flow restrictions!





- Adds no pressure drop — nothing inside pipe to interfere with fluid flow.
- Measures fluid velocity directly.
- Overall accuracy better than 1% of range over entire scale.
- Uniform flow scale.
- Full accuracy sustained even on liquids other meters can't handle: viscous, corrosive, or pulpy — even sand-water slurries.
- Easy range change — either by Multi-Point Switch or range coil replacement, as preferred.
- 2" to 8" sizes standard — larger sizes as required.

FOXBORO MAGNETIC FLOW METER



SIMPLE, TROUBLEFREE, OPERATION

The Foxboro Magnetic Flow Meter operates on the same principle as a power generator. A magnetic field (A) is maintained through a standard pipe section (B) of stainless steel or other non-magnetic material. This pipe section is lined with Kel-F® or other insulating material. Liquid passing through pipe acts as moving conductor, generating an electric voltage which varies in proportion to liquid's average velocity. Flush electrodes (C) in pipe wall "pick up" this voltage which is recorded in desired flow units by Dynalog Electronic Recorder or Controller.

This premium-performance meter measures *magnetically* the flow rate of virtually any liquid except hydrocarbons. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density, and viscosity. It even measures reversing flows.

Installation is simple. The magnetic spool piece connects into the line like any equivalent length of pipe — no seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Electronic Flow Recorder.

Maintenance is practically eliminated. There are no pressure taps to become plugged or frozen, no working parts to foul.

Foxboro Magnetic Flow Meters are already in use on such widely different liquids as beer, sand-and-water, rosin size, rock-and-acid slurry, viscose, and highly corrosive liquid detergent. Find out how this precise, troublefree flow meter can help *your* processing. Write for complete details.

THE FOXBORO COMPANY, 4610 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

FOXBORO
REG U S PAT OFF.

Foremost in FLOW METERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle 51 on inquiry card.

the INSTRUMENTS *and* ELECTRONICS

traveling show

Manufacturers of instruments, automation and electronic devices can display in 30 cities—at a cost of less than $200 per city!

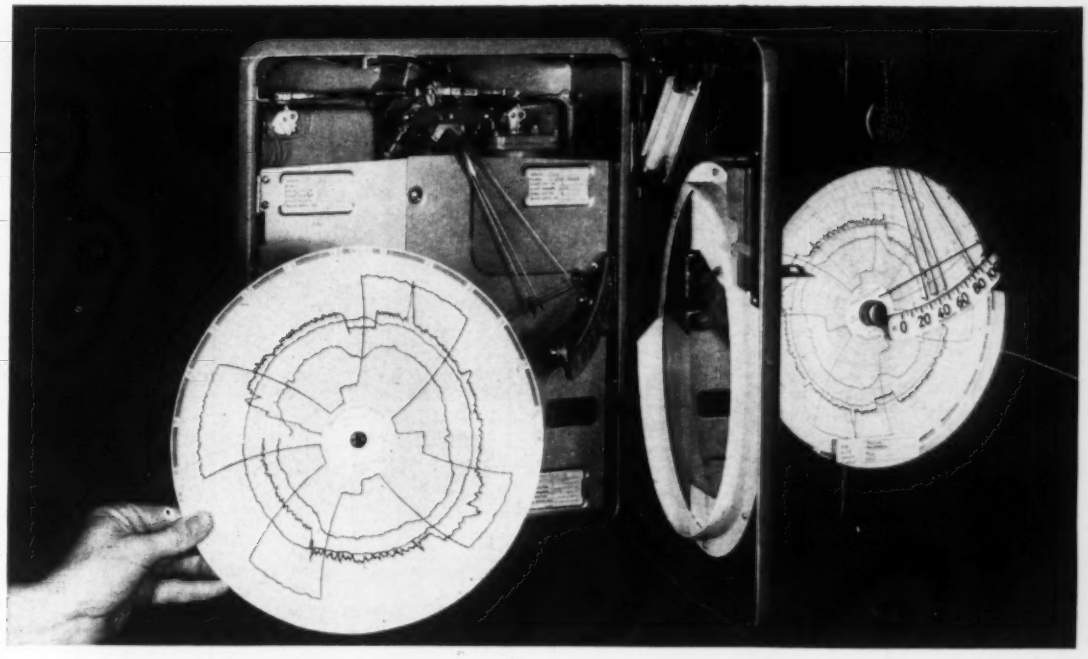
Now, for the first time, the instrument industry will have a means for reaching individuals never before contacted at the national, stationary trade shows.

The Show will move by a specially designed van; thorough and complete show management throughout its travel will be furnished by Richard Rimbach Associates.

Physical requirements will limit participation to 45 exhibit booths. Your prompt reply will guarantee inclusion in The 1956 Instruments and Electronics Traveling Show.

OVER 30 CITIES COAST TO COAST WILL BE ON THE ITINERARY

Write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa., or telephone FAirfax 1-9831



Faithfully yours -

Clear, Continuous Records without Poisoning . . . on the New Bailey Recorder

★ Faithful chart records of measured variables are the key to a meaningful, dependable analysis of operating trends and conditions. Money spent for more accurate metering, for faster response, is money down the drain—*unless* it's matched with chart records that are equally accurate.

That's why these features of the new Bailey Recorder are important to you:

1. Bailey's exclusive sealed capillary-action inking system maintains continuous flow to the pen tip, and traces sharp, opaque, quick-drying records. "Poisoning" of intersecting records is practically eliminated; no blots or smears during operation or chart changing.

2. Pens are mounted on concentric centers, trace on parallel time arcs only 42/1000" apart. This simplifies analysis of two or more records.

3. Interchangeable plug-in receiver units permit practically limitless record-grouping combinations.

Write for Product Specification E12-5 and actual chart sample. P32-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

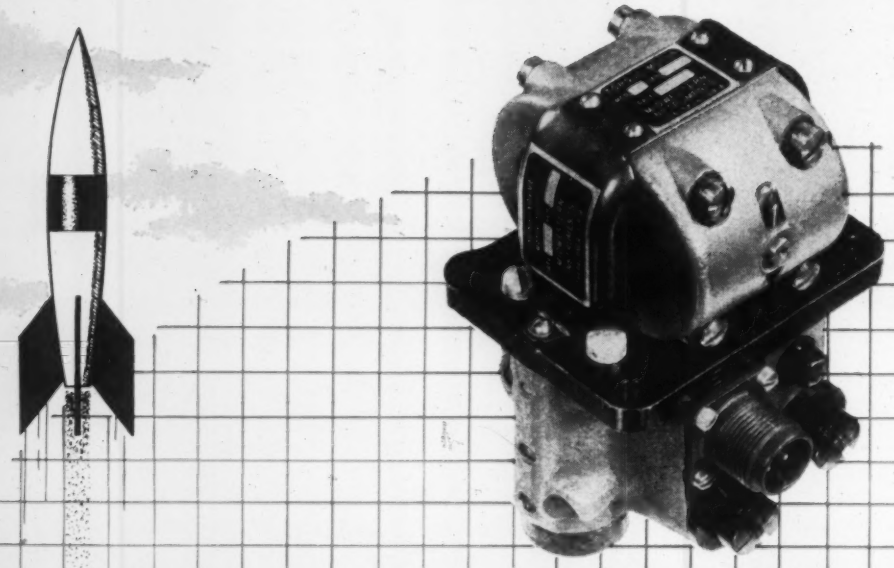
- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster shipment—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY
METER COMPANY
1041 IVANHOE ROAD
CLEVELAND 10, OHIO
Controls for Power and Process

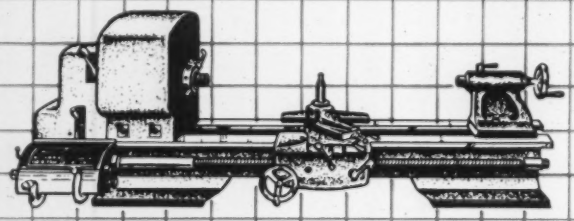
BAILEY METERS
Controls for
TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

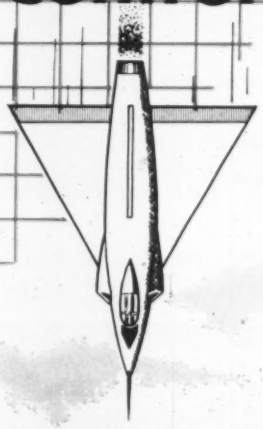
For more information circle **52** on inquiry card.

MIDWESTERN'S proven Servovalves can solve your problems



for Automation and Control





products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
- MAGNETIC STRUCTURES
- GALVANOMETERS
- AMPLIFIERS
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- TORQUE MOTORS
- SERVOAMPLIFIERS
- DATA REPEATERS
- WATERPROOF CONNECTORS
- GEOPHYSICAL EQUIPMENT

For servovalves—components, or complete systems for control or automation in ANY industry . . . Midwestern production facilities can help you solve your problems.

Write for Assistance with your Automation or Control problems

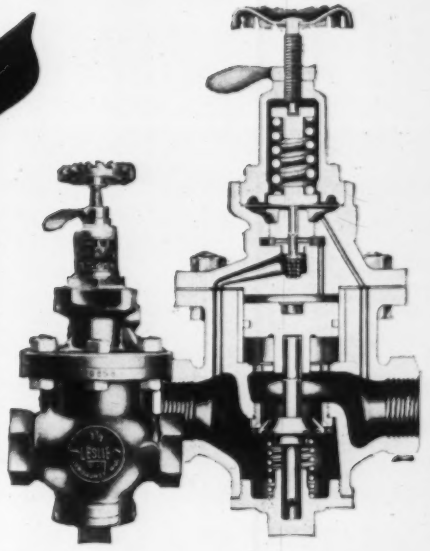
MIDWESTERN MI INSTRUMENTS

MIDWESTERN INSTRUMENTS

41st and Sheridan Road — Tulsa, Oklahoma

For more information, circle **53** on inquiry card.

the PRESSURE'S ON!



STEADILY,
CRITICALLY,
AUTOMATICALLY, with **LESLIE**

PRESSURE REDUCING VALVES

No need for costly, complicated two-stage reducing stations when you handle high pressure drops with Leslie Pressure Reducing Valves . . . *ideal* for steam heating installations or for process reductions.

Leslie design, materials and workmanship have proved successful for more than 55 years in all kinds of industrial heating applications. The single-seated, internal pilot, piston operated construction of Leslie regulators can handle pressure drops up to 1500 psi and higher and are being used successfully in pressure generating stations all over the U. S.

Send for the bulletin described below today.

- **For Steam, Air, Gas**
- **99% Accuracy of Regulation**
- **Instant Reaction to Flow Change**
- **Stellited Seating Surface**
- **Positive Dead-End Shut-Off**
- **Interchangeable Parts**

BULLETIN 5302

Provides latest engineering data on all classes of Leslie Pressure Reducing Valves—assists you in planning and specifying for optimum performance. Yours on request.

TYPICAL PRESSURE RANGES				
CLASS	BODY MATERIAL	SIZES	INLET STEAM PRESSURES	REDUCED PRESSURE RANGE
LLK	Cast Iron	½"-6"	25-250	2-35
LK	Cast Iron	½"-6"	25-250	10-235
LL-3	Cast Bronze	½"-4"	25-300	2-35
L-3	Cast Bronze	½"-4"	25-300	10-285
LL-4	Cast Bronze	5"-6"	40-300	5-35
L-4	Cast Bronze	5"-6"	40-300	20-275
IS-2	Cast Carbon Steel & Cast Alloy Steels	½"-3"	300-750	100-600
HS-3		1"-3"	300-1500	100-600

TRADE LESLIE MARK

LESLIE CO., 299 Grant Avenue, Lyndhurst New Jersey

For more information circle **54** on inquiry card.

This electronic Speedomax instrument, calibrated in % ethane plus methane in ethylene, is panel-mounted in the Port Arthur control room to serve as recording teammate to the L&N Analyzer.

Infrared analysis helps Gulf to pipe "on spec" ethylene directly to consumers, without tankage or sampling

There's no costly storage—no laborious sampling or blending before shipment of the high-purity ethylene produced at Gulf Oil's Port Arthur Refinery. Operators are *certain* that the plant stream is always "on spec", as it runs from production directly to pipelines serving the ethylene-hungry industries of the Houston—Sabine River—Port Neches area.

One reason for such confidence in product quality is the L&N Infrared Analyzer that Gulf has installed to constantly monitor impurities in the ethylene stream. Should the sensitive Analyzer detect a predetermined percentage of impurity, operators can promptly divert "off spec" stream before "on spec" product in the lines can be contaminated.

Even though subjected constantly to the vibrations of a pipeline mounting, and electrical pick-up from pumps and compressors, the Analyzer checks consistently with daily spectrometer analyses—a tribute to the L&N instrument's all 'round dependability.

The Analyzer's prominent role at Port Arthur is duplicated in many other successful applications of this versatile instrument. It's measuring CO and CO_2 in the steel industry—SO_2 in H_2SO_4 stack gas—methane build-up in ammonia production—isobutane loss in petroleum. It may well be the yardstick *you* need in your own gas measurements.

Our Applications Lab is staffed with specialists glad to discuss your use of infrared. Outline your requirements, without obligation, in the Infrared Analysis Data Sheet we'll mail on request. Or, just write for our Demonstrator, "How the L&N Infrared Gas Analyzer Works." The address is Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa.

LEEDS [LN] **NORTHRUP**
instruments — *automatic controls • furnaces*

For more information circle **55** on inquiry card.

Editorial...

INSTRUMENTS and AUTOMATION

Automation Exposition Developments

FOUR conferences and clinics are now coordinated with the forthcoming Second International Automation Exposition, to be held on the Chicago Navy Pier Nov. 14-17. These affairs show the wide appeal of the term "automation," and emphasize the broad character of this exposition.

1. *Office Automation Conference for Senior Officers*

An Office Automation Conference for Senior Officers will be held at the Shoreland Hotel, Nov. 14-15, 1955. Sponsored by the University College, University of Chicago, the program includes sessions on:

What is Automation?
How Electronic Computers Work
Automation and the Processing of Business Data
Automation and Research
What is Automation's Effect on the Organization of Business?
What is Automation's Effect on Top Management?
What Influence will Automation Have on the Development of Public Relation Practices?
Evaluating Automation's Place in Your Business
Organization for Conversion to Automation
Automation—Now or Later?

Industry Sessions on:

(Group I) Utilities
(Group II) Insurance
(Group III) Manufacturing
(Group IV) Merchandising
(Group V) Transportation

Importance of Data Processing to the Senior Officer

This program will undoubtedly appeal to top executives (Senior Officers) throughout the nation. Registration fee is $150. Coordinator of the Conference is Gordon L. Mattson, Coordinator of Senior Officer Conference on Office Automation, University College, University of Chicago, 19 S. LaSalle St., Chicago 3, Ill. Registrants to this Conference will be interested in the Computer Clinic equipments with office-automation implications.

IMPORTANT CORRECTION

Editor, I & A:

I find in the August issue of *Instruments and Automation* that an error has occurred in the printing of my letter of July 26. With reference to the last line of that letter, the temperature of the triple point of water is +0.0100° C, not −0.0100 as printed.

J. F. Swindells,
Chief, Temperature Measurement Section,
National Bureau of Standards

2. *Midwestern Simulation Council*

The Midwestern Simulation Council has scheduled their next meeting for Nov. 14, at the St. Clair Hotel, two blocks from the Automation Exposition. This group of men will be interested in the analog computer sessions of the Computer Clinic of the Automation Exposition. They have selected the subject "Patch Board Systems for Analog Computers" as their topic, and will have representatives of five computer manufacturers describe their patch board systems indicating the philosophy behind the design. One nonpartisan who has used four different types of patching systems will discuss his views on the subject. Meeting is at 1:00 PM, St. Clair Hotel, Chicago, Monday Nov. 14. (We expect a little fireworks on the subject of patchboards at this meeting.)

3. *Computer Clinic*

The Second Computer Clinic will be held Nov. 15, 16, and 17—the last three days of the Automation Exposition. Registrants can select six of the following nine sessions:

1. Special-purpose Computers—Conducted by The Austin Company
2. General-purpose Digital Computers—Bendix Computer Div., Bendix Aviation Corp.
3. General-purpose Analog Computers—Berkeley Div., Beckman Instruments
4. TapeDRUM Data Processing, A New Concept of Automatic Data Handling—Clevite-Brush Development Co.
5. General-purpose Analog Computers—Electronic Associates, Inc.
6. General-purpose Analog Computers—Goodyear Aircraft Co.
7. Electronic Data Processing Machines—International Business Machines
8. General-purpose Digital Computers—Librascope, Inc.
9. Data Handling Systems—Teleregister Corp.

Advance registration to this important Computer Clinic is available (see card on page 1783).

4. *Conveyor Clinic*

Emphasizing the materials-handling (as well as the data-handling) aspect of automation will be the Conveyor Clinic, also to be held at the Automation Exposition in Chicago. Armand T. Gaudreau, Management Consultant, Westport, Connecticut will direct the Conveyor Automation Clinic Sessions.

"Doc" Gaudreau has conducted courses for engi-

neering executives and management personnel, including the Conveyor Institute arranged by the University of Illinois in 1953, in cooperation with The Conveyor Equipment Manufacturers Association.

Each lecture of the Clinic will be focused on a different, functional phase of the application of conveyors in supplying the prime mechanism to automation:

1. Work positioning at the machines.
2. Inter-machine transfers of materials.
3. Inter-flow handling of materials.
4. Inter-building transportation of materials.
5. Automatic handling from assembly to storage.
6. Integrating Material flows through production.

The following conveyor manufacturer exhibitors are participating in the conveyor clinic:

Chainveyor Corporation
Mechanical Handling Systems, Inc.
Jervis B. Webb Company
Weighing Components, Inc.

These four activities (coordinated with the Automation Exposition) plus the Diamond Jubilee Meeting of the ASME, Chicago, Nov. 13 to 18, will make Chicago the Automation Center of the world on the dates Nov. 14, 15, 16, and 17.

Needless to say, hotel reservations should be made in advance. A listing of exhibitors and exhibited products appears on pages 1641-1649.

Comments on ISA Conference & Exhibit

INTENSE interest in automatic control and instrumentation (plus Herculean efforts by the California section of the ISA) overcame the heat and smog to make the Tenth National ISA Conference & Exhibit, Sept. 12-16, Los Angeles, an outstanding success.

The trends revealed were those first brought out at the Cleveland and Philadelphia exhibitions—particularly digital representation of data plus integrated data-handling

Richard Rimbach receives award from Warren Brand, ISA president.

systems, including computer functions where necessary. This aspect of instrumentation is electronic in nature.

In the field of process control, competition between electronic and pneumatic techniques continues apace. In last year's show report your editor singled out the then experimental electro-hydraulic valve operator of Manning, Maxwell & Moore as a product with important implications for the future. Our prophesy is repeated; the Canadian Petrofina Refinery is now on stream using this valve operator that obviates need for any air supply; the results will be watched carefully. The LA Show was characterized by intense interest in valve operators of all types—

Bill Wildhack congratulates Mal Behar upon receiving award.

pneumatic, electropneumatic, and electrohydraulic.

Vying for title of "chief attraction" of the LA Show were numerous models (blonde and brunette, as well as analog and digital). The reactor simulator of Leeds & Northrup was particularly popular, a reflection of the high appeal of nuclear developments.

Also of particular importance should be mentioned the ultrasonic flowmeter of Fischer & Porter, introduced at the Show as "the world's first successful industrial ultrasonic flowmeter." The unique features of this industrial flowmeter include (1) no restriction in flow line, (2) no pressure loss, and (3) independence of the electrical conductivity of the medium. See page 1656 for details.

Another development that is symptomatic of a trend was the introduction of the "Dynagraphic" miniature electronic process controllers by the Bristol Company—

Continued on page 1638

Dr. A. O. Beckman presents Dr. Lee DeForest with special "Achievement Award."

Honors and Awards Committee Nominates Richard Rimbach and Manoel F. Behar For Honorary ISA Memberships

"Mal" Behar

Reprinted from the ISA JOURNAL. Vol. 2, No. 9, September 1955

"Dick" Rimbach

Richard Rimbach, publisher of *Instruments and Automation* has been nominated by the Houston Section of ISA for Honorary membership in the Instrument Society of America. Also, Manoel F. Behar, Editor Emeritus of *Instruments and Automation* has been nominated by the Washington Section of ISA for Honorary membership in the Instrument Society of America.

Both nominations have been approved by the Honors and Awards Committee consisting of William A. Wildhack, Porter S. Hart, and Arnold O. Beckman. Both nominations are also unanimously approved by the Executive Board. Formal approval action will be taken by Council.

Presentation will be made on Wednesday, September 14th, at the ISA Annual Banquet.

The citation for Mr. Rimbach reads as follows:

For his distinguished activities during more than 25 years in forwarding the art and science of instrumentation, particularly for his leadership in founding the Instrument Society of America, for his development of the ISA Instrument Exposition, for his services as the first Executive Secretary of ISA, and for his contributions to progress in instrumentation as publisher of the Instruments and Automation magazine.

The nominators' statement for Mr. Rimbach reads as follows:

"Richard Rimbach was born in New York City on December 24, 1895. He received his education at the Massachusetts Institute of Technology and at Harvard University. By training and experience he is a metallurgist. In 1928 he founded *Instruments* magazine, and continues to publish it as *Instruments and Automation*. He is president of the Instruments Publishing Company which publishes *Instrument Manufacturing* and books on instrumentation.

"Mr. Rimbach was one of the leaders in the founding of the Instrument Society of America in 1945-1946; served as its Executive Secretary through 1951; managed its instrument exhibits through 1954; and contributed office space and services to the Society during its early years.

"He has given generously in time and space in his publications to projects for the general good. As an example, he was a leader in establishing the Gibson Island (now Gordon Research) Conference on Instrumentation.

"For his outstanding service to the Society and to instrumentation in general, the Houston Section nominates Mr. Rimbach for Honorary membership in ISA."

"The citation for Major Behar reads as follows:

For his distinguished role in all activities fostering the art and science of instrumentation during the past 30 years, particularly for his contribution to the terminology and to the basic literature of instrumentation, for his vigorous pioneering efforts as editor of Instruments and Automation to develop a professional status for instrumentation and to found the Instrument Society of America.

The nominators' statement for Major Behar reads as follows:

"Major Behar was born in France on February 7, 1889. He received his education in France, Switzerland and England and in this country at the Pratt Institute and Columbia University. After a tour of duty as an officer in Infantry and Ordnance during W W I and employment by several industrial concerns, he became, in 1929, the editor of the magazine started by Richard Rimbach. He held this position until 1955 and is now editor-emeritus.

"The Major, as he is called by his friends, has filled a unique position in the instrument field due to his talent for exposition and his unselfish espousal of all projects and causes which would forward the art and science of instrumentation, sometimes with a fervor and intensity which surprised the sponsors. He helped greatly with his writing using "Instruments" as his forum, in establishing the Gibson Island Instrumentation Conference, now the well-established Gordon Research Conference on Instrumentation. His advocacy of the formation of an instrument society was very helpful in bringing about the organization of our Society and contributed materially to its quick, necessary growth.

"Major Behar has been working on handbooks on instrumentation for 30 years, which are distinguished by an effort to clear instrument terminology and concepts from ambiguity, in effect to clarify the fundamentals. His efforts in this difficult field have met with some success. One of his handbooks was published in book form in 1932, a number of others were serialized in Instruments. Under his editorship two handbooks on instrumentation were published in 1951 and 1954, of which one-half was written by him. Their quality reflects his growth and that of instrumentation to technical maturity.

"Through the years he edited as a cherished task the New Instruments column of *Instruments & Automation*. To this task he brought the ideal of adequate technical information in each item, a goal often frustratingly unrealized in spite of all efforts.

"For his accomplishments and principally for his high ideals for instrumentation, the members of the Washington Section have nominated Major Behar, the first major prophet of instrumentation, as an Honorary Member of ISA."

thereby adding electronic controllers to the existing pneumatic controllers of this company that specializes in process instrumentation.

A highlight of the Conference was the awarding of Honorary Memberships in the ISA to Major M. F. (Mal) Behar and Mr. R. (Dick) Rimbach, both of the Instruments Publishing Company. These honors were well-deserved recognition of the work of two pioneers in the field of instrumentation, two men who have devoted most of their lives in dedicated service to instrumentation in general—and to the ISA in particular.

The ISA also conferred a "Special Achievement Award" to Dr. Lee DeForest, whose audion tube invention in 1907 made possible not only radio and TV, but the electronic instruments displayed in such large number at the Show.

We bring you some other comments on the ISA Show, by Editor McLeod, below.

Editor McLeod Comments on ISA Show:

The ISA Conference and Exhibit could not have opened under more unfortunate circumstances—heat and smog combined to make those attending miserable. My eyes watered so much that I could not appreciate what I saw (even the Daystrom models), and this got my nose to running as though I had hay fever. So the honking in the technical sessions on the part of almost everyone was quite disconcerting.

After a slow start the attendance picked up daily until a final count showed that 15,402 people were registered, a large proportion of them on Thursday evening. There were 327 exhibitors occupying 526 booths, and the dollar value of the exhibits was in the millions. I don't know how to estimate it, but some of the exhibits, e.g. those of Swartwout (showing a large graphic panel by Panellit) and the Beckman group, displayed about $80,000 worth of equipment.

Technically, the most interesting event of the conference to me was the Data-Handling Work Shop. I attended the Work Shop for two reasons: (1) The idea of having a group of "bull sessions" which one could wander into and out of as his interests dictated was to me a new one which I thought might resolve some of my complaints about convention technical sessions. I wanted to see how it worked. (2) I was also particularly interested in the analog-to-digital converter bull session because I thought that represented the area in which analog and digital techniques must cooperate if the advantages of both are to be made the most of.

The Work Shop did not disappoint me. The general idea seemed to work well, except that it constitutes an unstable situation. People would, quite naturally, drift away from less interesting sessions and make them still less interesting, and vice versa. Some of the discussions in the analog-to-digital converter session proved rewarding, particularly when I asked why anyone would wish to convert from analog to digital information anyway. There were some good answers, as follow:

(1) Because it is sometimes desirable to handle processing of information by digital techniques. For instance, in some aircraft applications where multiplexing (a natural with digitals) allows the handling of many computations by one small computer; or because the math involved can be better handled by digital equipment, as for instance when small differences of large numbers are involved.

(2) When it is desired to transmit information over a noisy channel. Bonney of Electronic Engineering Company of California reminded us of this respect that though digitalizing is a technique for obtaining noise-free transmission, on the other hand if there is noise present upon digitalizing it is not possible to subsequently separate it.

(3) If it is desired to store information.

(4) If only digital equipment is available for processing the information.

I also attended other technical sessions. Speeches that

I heard on process control, notably talks Nos. 55-6-2 and 55-6-3 and 55-13-1 through 5, used a lot of math to find out what any control man could have told them to begin with. We are now in that stage of development of process control where the science is struggling to catch up with the art. When it does, then we shall see *real* progress. *It is to aid this art-to-science transition that we dedicate our computer-in-plant project.*

A paper which I considered of special interest was that by Chal Jones (55-25-3); to say more about that would sound too much like a plug.

As to the exhibits, the one which I found most interesting (as would most others interested primarily in simulation) was the Leeds & Northrup nuclear reactor simulator. This whole display operated around an analog of an actual nuclear reactor. The general public liked it too—their demonstrations every half hour blocked the aisle with more people than could possibly have been interested in simulation, the Simulation Councils and the *Newsletter* notwithstanding!

Another exhibit which I don't know how to classify but which I thought I would never see—a Heath Kit Computer. Seems our long-time friend and charter member of the first Simulation Council, Chalmer Jones, an alumnus of Berkeley Scientific Division of Beckman Instruments, got himself a job as Assistant to the President of Heath Company and did the functional design of the computer. For my money it is a doggoned good design too, offering many advantages to the operator not found in more expensive equipment. It is expected to sell for about $750 for a 15-amplifier, 30-pot kit, and should fulfill a real need with educational institutions where budgets are low and the assembly can be made part of the education.

Neither do I know how to classify Bob Lowry's (Pioneer Division of Bendix, Davenport, Iowa, and the motivating influence behind the formation of the Midwestern and Eastern Simulation Councils) exhibit of ultrasonic cleaning devices in which he claims you can dunk complete amplifiers and other delicate electro-mechanical devices in a detergent solution, and then bring them out not only unharmed but sparkling clean with the attendant improved electrical characteristics!

Tallest exhibit—that of Minneapolis-Honeywell—located in approximately the center of the exhibit area, literally towered over everything.

My over-all impressions of the Show were:

(1) It could have been better publicized.

(2) It should have been better timed so that it would not conflict with Association for Computing Machinery in Philadelphia etc., and follow so closely on the heels of the tremendously successful WESCON.*

(3) Downtown Los Angeles is a lousy location for anything, even if there isn't any smog.

(4) Everyone wants to get in the automatic control act, so interest was high enough to overcome the aforementioned drawbacks.

(5) There is an increasing awareness of the importance of analog computers. Goodyear, Beckman, Electronic Associates, and Heath exhibited. Among the digitals, ElectroData had an exhibit, though IBM and Rem-Rand did not. And the Burroughs computer, which was shown, boasts patchboards which, it was intimated, allow you to set up like an analog. There was also many special-purpose analog-computing devices embodied in instruments (for instance, the Southwestern Industrial Electronic Company's flowmeter which uses magamps to do the necessary computing to give digital readout of total flow from pressure and differential-pressure inputs).

(6) If you have the money and the interest, you can buy anything to do anything.

John McLeod, Jr.

**Instruments and Automation* has a complete calendar of events for 3 years in advance, which we maintain as a "clearing house" of available, nonconflicting dates for technical meetings. This service is available to all societies.—Ed.

Reaction to the Peterson Microbalance Disclosure

As was anticipated, the disclosure (in the July issue of *Instruments and Automation*) of the recording microbalance developed by Dr. Axel Peterson at the Mellon Institute of Industrial Research has had the effect of a bombshell dropped into microweighing circles. Readers were quick to point out that the disclosure did not adequately dispose of the following problems common to all microweighings:

(1) Sensitivity to tilt of balance table.

(2) Linearity versus large deflection of pointer, arising from nonlinearity of differential-transformer action.

(3) Lack of small weights (with which to verify the sensitivity in the microgram region).

(4) Air-current effects on the large pans of the conventional balance used.

(5) Temperature-gradient effects on beam.

Points 1, 3, 4, and 5 will be recognized at once as problems common to all conventional microbalances—and the point is well taken by our critical readers that these factors were not dealt with in the *Instrument and Automation* first disclosure of the Peterson balance. Point 2 alone is unique to the Peterson balance.

Let us consider these factors in reverse order. Factor 5 refers to the temperature-gradient effect on the beam. For fractional-microgram weighings, the beam of any microbalance must attain a constant temperature. This is true no less of the Peterson balance than of any microbalance—except that the heat due to the electrical energization of the differential transformer in the Peterson balance could be an added source of trouble. However, the energy from the diff-tran is only in the order of milliwatts.

Factor 4 refers to air-current effects on the relatively large pans of the conventional analytical balance converted into a Peterson microbalance. All microweighings should be done with the balance completely shielded from ambient air motions (including temperature control of the ambient atmosphere).

Factor 3 refers to lack of small weights for calibration and sensitivity verification. It is admitted that the Peterson balance is in its early design. As of today it is cali-

brated by larger weights while at reduced sensitivity, and then the sensitivity is increased by precision voltage dividers of known attenuation. Although the technique appears reasonable, it can have hidden defects of non-linearity somewhere within the system, particularly in the forces within the differential transformer. This should be capable of early verification by cross-checking against microbalances of more conventional design. Work is underway on this problem.

Factor 2 raises the question of the linearity of the differential transformer, which will affect the calibration. This point is related to the linearity of the electrical restoring forces within the differential transformer, an important factor now under investigation.

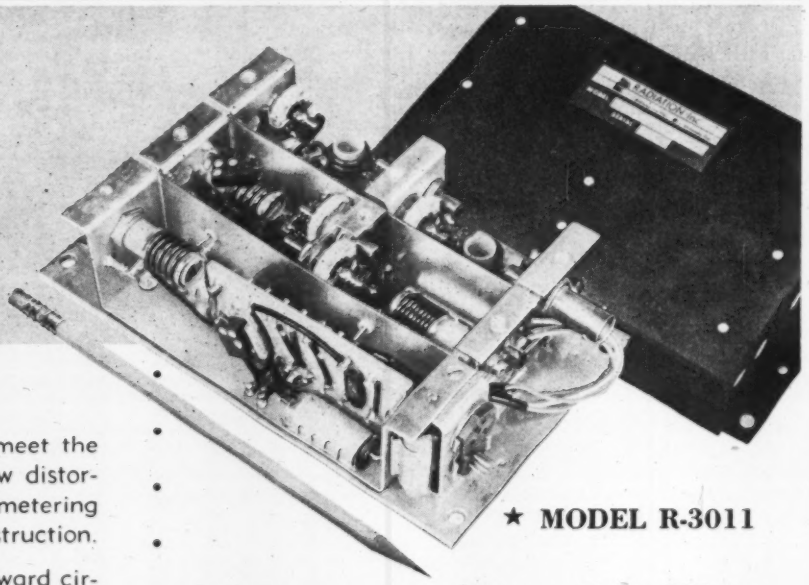
THE final factor is factor 1. This has been left for the end of this discussion because another startling development appears to have been the result of the investigation of this matter, an investigation prompted by the response of our readers to the original disclosure.

It is well known that the effect of orientation of the beam mass of a conventional balance is reduced by locating the mass at the center of gravity of the scale—however, the balance becomes unusable at this point because there is no restoring force due to gravity; the slightest unbalance causes the beam to deflect until it hits the stops. Dr. Peterson, with what can be characterized as a true stroke of genius, patiently balanced his modified balance in this manner, in order to ascertain if the electrical forces alone could be relied on for the restoring force. This experiment will long be remembered, because he found that the electrical forces alone were adequate when the balance was completely balanced mechanically, at which point the effect of gravity on the beam mass was eliminated entirely. It will be recognized that this made the balance almost completely insensitive to orientation—and opens the way to the microbalance without concrete-pier support. A report on this work is now in preparation by Dr. Peterson and will appear in an early issue of *Instruments and Automation*.

The National Bureau of Standards has taken cognizance of the development. Dr. Peterson and Bureau of Standards' personnel have exchanged visits to discuss balances and microweighing technique. L. B. Macurdy, Chief, Mass Unit, Mass and Scale Section, National Bureau of Standards, has made plans to evaluate the Peterson development. Mr. Macurdy, who has what is probably the world's most complete assortment of microbalances, has elaborate instrumented balances for the measurement of temperature and humidity effects on weighings. Your editor predicts some basic disclosures in the near future—disclosures highlighting the awesome inadequacies of existing balances. *I&A* has been assured of preferential treatment of the data; we will keep the field of analytical weighing informed of each development as quickly as possible.

Although a letter to your editor said that "the spectacular claims [for the Peterson microbalance, as reported in the July issue of *Instruments and Automation*] do not seem to be justified," we submit that even more spectacular developments will result. The design of the analytical balance of the future is emerging. MHA

CRYSTAL CONTROLLED
FM
TELEMETERING TRANSMITTER



The R-3011 was developed to meet the need for a low microphonic, low distortion, subminiaturized FM Telemetering Transmitter of ruggedized construction.

Unique utilization of straightforward circuits and crystal control provides a very linear true frequency modulated output under extreme environmental operating conditions.

★ MODEL R-3011

- Frequency Output Range .. 215 to 235 mc
- Power Output _____ 3 watts
- Weight _____ 1.7 pounds
- Ruggedized
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For more information circle 56 on inquiry card.

SECOND INTERNATIONAL AUTOMATION EXPOSITION

EXHIBITORS and their PRODUCTS

Booth No.

ADVANCE ELECTRIC AND RELAY CO., Burbank, California 468
Exhibiting: New Products—Elgin "Neomite" world's tiniest relay (1/16 ounce, designed for control systems, computers and specialized electronic equipment); "SO" series of Advance relays (sensitive relays) **Regular Products**—complete line of relays from sensitive miniatures to high-power transfer type, with many designed for special control purposes.
In attendance: Edw. C. Carlson, Elec. Div. Sls. Mgr.; A. P. Barton, Gen. Mgr. Elec. Div.; Eric Firth, West Coast Adv. Rep.; Lee, John Cahill, Midwest and Eastern Sls. Reps.

ALDEN SYSTEMS, Brockton 64, Mass. 147, 148
Exhibiting: Fabrication set-ups; Recorders.

ALLEGANY INSTRUMENT COMPANY, INC., Cumberland, Md. 333
Exhibiting: New Products—Type K-2, Computor for Dynamation (works directly from wire strain gages and other transducers and supplies all pertinent electronic information on a dynamic test); Type C, Calibrator (for calibration of all types of wire-strain-gage transducers). **Regular Products**—Portable Potentiometers; Cathode Ray Oscillographs, DC Amplifiers; Millivolt Sources; Drum Cameras; Time Rate Displacement Cameras; Time Standard for Optical Recording; Electronic Integrator; Hazardous area Ohmmeter; Multi-Channel Cathode Ray Recorder.
In attendance: Harry Stern, Pres.; John B. Zornig, Sls. Engr.; G. William Harrison, V. P.; Charles M. Minke, Prod. Supt.
See ad on page 1757

AMERICAN ETAMIC CORPORATION, New York 22, N. Y. 105, 106
Exhibiting: New Products—Wire Measuring Gages for Bare or Insulated Wire. Equipment for automatic control of processing equipment within established limits or by measurement. **Regular Products**—Autosizing equipment for machine tools including cylindrical, surface and centerless grinders. Comparators, normal and differential; Multi-Dimension Checking and Inspection Equipment; High Speed close tolerance Inspection Unit which eliminates Go-NoGo gages.
In attendance: Sherman Ewing, Pres.; Prof. Andre Fortier, Engr. Consultant; Wm. T. Maguire, V. P.

AMERICAN HELICOPTER DIV. OF FAIRCHILD ENGINE & AIRPLANE CORP., Costa Mesa, Calif. 310
Exhibiting: New Products—Voltage ratio indicator Model 301, for resistance transducer calibration and check-out; measures resistance potentiometer voltage ratio to 0.5%; calibrates at 0.000, 0.500 and 1.000 voltage ratio. Also measures resistance in ohms up to 10,000 full scale. **Regular Products**—Resistance bridge indicator—Models 101A & 201A; Bridge Balance Models BF-18A & BF-18B.
In attendance: C. W. Lefever, Mgr. Contracts & Customer Relations; L. Emmerich, Chf.-Test & Instrumentation.
See ad on pages 1676, 1704, 1770

AMERICAN PHENOLIC CORPORATION, Chicago 50, Ill. 463
Exhibiting: New Products—Hermetically Sealed Headers (compression type seals electro-tin plated and Dow Corning Silicone treated); Subminax subminiature RF connectors; "Potted" connectors. **Regular Products**—A-N connectors; Microphone connectors; electron tube sockets; RF cable; antennas; Cable assemblies; Radar and radio components; plastics.
In attendance: W. H. Rous, V. P. & Dir. Sls.; R. M. Soria, Dir. Engr.; Richard E. Hall, Gen. Sls. Mgr.; Roy J. Gallagher, Fld. Office Sls. Mgr.; James H. Schaefer, Chicago Dist. Sls. Mgr.; Charles Mikl, Gen. Prod. Mgr.; James Burke, Robert Monroe, Q. Lockhart, Sls.; K. F. Boldt, Adv. Mgr.; Lee Allen, Adv.

AMERICAN T.V. AND RADIO, St. Paul 1, Minn. 408

ANALYTICAL MEASUREMENTS, INC., Chatham, N. J. 211
Exhibiting: Analytical Pocket pH Meter.
In attendance: Frank G. Paully, Sls. Mgr.; Kurt J. Lesker, Jr., Sls. Engr.

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio 425, 426
Exhibiting: New Products—Panel meters, pyrometers, and sensitive meter-relays in ruggedized and sealed 2½" round (Model 255) and 4½" round (Model 455) styles. Panel meters, pyrometers, and sensitive meter-relays in a new 4½" rectangular style (Model 461). Simplytrol temperature controls and Versatrol automatic control (for other variables) in redesigned modern appearance and reliable motor driven interrupter. "Minimum frontal area" version of Simplytrols and Versatrols will also be displayed. **Regular Products**—Panel meters, pyrometers, and sensitive meter-relays. Standard Simplytrols and Versatrols. VHS (very high sensitivity) relays. Model 355 3½" round ruggedized, sealed Panel Meters, Pyrometers, and Sensitive Meter-relays.
In attendance: John Saint-Amour, V. P.; Bradley Thompson, Pres.; Robert H. Pugsley, Robert E. Jones, Dave Dolan, Div. Mgrs.; Lionel Glauberman, E. E.; Paul Saint Amour, Sls. Engr.
See ad on page 1702

ATOMIC INSTRUMENT COMPANY, Cambridge 39, Mass. 142
Exhibiting: Industrial Counters and Controllers for totalizing and control production processes, featuring unitized construction flexibility for counting discrete items, linear flow, and continuous liquid flow. Speeds above 20,000 counts per second are available.
In attendance: T. Voutselas, Appl. Engr.; L. Packard, L. Slattery, Sls. Engrs.
See ad on page 1776

AUSTIN CO., SPECIAL DEVICES DIV., New York 11, N. Y. 456, 457
Exhibiting: Data recording equipment—electronic; computers—analog, digital, special purpose; analog to digital convertors; servo-mechanisms; control systems—electronic, special purpose.
In attendance: A. H. Kuhnel, Div. Engr. & Asst. Div. Mgr.; W. G. Birkel, Sls. Engr.; Charles Cole, Proj. Engr.

Booth No.

AUTOMATION CONSULTANTS, INC. New York 18, N. Y. 169

AUTOMATION CORPORATION OF AMERICA, North Hollywood, Calif. 430, 431
Exhibiting: New Products—Numerical systems for magnetic programming of power machine tools; Automation components. **Regular Products**—Magnasync magnetic film recorders & reproducers; Multichannel magnetic recording and playback heads.
In attendance: D. J. White, Pres.; W. H. Stutz, V. P.; J. W. Green, V. P.; O. I. Dupy, Proj. Eng.
See ad on page 1690

AUTOMATIC ELECTRIC SALES CORP., Chicago 7, Ill. 119, 120
Exhibiting: New Products—Telephone-type improved life relays for direct insertion into printed circuits. Series OCS Relays for programmed on-off sequential or interlock operation. **Regular Products**—Telephone-type Relays and Switches, both open and hermetically sealed. Full line of Telephone-type components for both automatic and manual control, signalling, supervision and communication functions.
In attendance: V. E. James, Mgr., Indust. Control Equip. Sls.; J. D. Ashby, Asst. Mgr., Indust. Control Equip. Sls.; J. A. Rudy, R. O. Welch, H. F. Hallstrom, O. B. Ellison, K. K. Aagaard, Salesmen; L. E. Savage, Dist. Sls. Mgr.; E. C. Coulombe, Engr.; W. E. Ploeger, Engr.
See ad on page 1617

AUTOMATION ENGINEERING LABORATORY, INC., Greenwich, Conn. 329
Exhibiting: New Products—Conveyor with versatile automatic feature Automatic control function display. **Regular Products**—Special Automatic Machinery and Controls.
In attendance: Richard S. White, Gen. Mgr.; Robert C. White, Sls. Mgr.; Paul C. Martin, Sumner C. Willis, Sr. Stf. Engrs.; Ray Long, Proj. Engr.; Donald Beaman, Proj. Engr.

AVION DIV. OF ACF INDUSTRIES, INC., Paramus, N. J. 141
Exhibiting: New Products—Automatic well-test control and recorder for tests of petroleum wells in remote locations, such as offshore platforms. Information is transmitted over private or leased wires or wire links. Control uses dial telephone techniques and directs the flow from the well through a test separator for a given test period. Data transmitted in code to a teletype punch at a remote location. **Regular Products**—Model 400 Frequency Convertor; Electronic Weighing Controller and recorder.
In attendance: B. J. Kaplan, Mgr. Contract Relations; S. B. Blodgett, Mgr. Spec. Prod.; C. L. White, Sls. Engr.
See ad on page 1663

A V MANUFACTURING CORP., New York 19, N. Y. 448, 449
Exhibiting: New Products—Two new Magnetic Tape Recorders designed for controlling all types of automatic machines; Fast Start-Stop Digital Magnetic Tape Equipment with start-stop time of less than 5 milliseconds; Fast Start-Stop Analogue (Digital Magnetic Tape Equipment) provides stabilized tape motion with low wow and flutter. **Regular Products**—Instrumentation type Magnetic Tape Recording Equipment.
In attendance: Charles E. Rynd, Pres.; R. E. Hadady, V. P.-Fld Engr.; H. Norwood, J. Held, Fld. Engr.

THE BAKER COMPANY, INC., Maplewood, Maine 126, 127
Exhibiting: New Products—Model 10 Sterilshield. **Regular Products**—Sterilshield Cabinets (dust free workbenches); Bearing Torque Testers; Instrument Bearing Tools.
In attendance: A. K. Baker, Pres.; E. M. Baker, V. P. & Treas.; Frank Potenzo; Don Ricker.
See ad on page 1767

BARBER-COLMAN COMPANY, Rockford, Ill. 205, 206
Exhibiting: Automatic controlling instruments for temperature, humidity, pressure, liquid level, moisture; Motor-operated valves, solenoid valves; Electric power units, damper controllers; Voltage sensitive relays.
See ad on pages 1656, 1657

BARNES & REINCKE COMPANY, Chicago, Ill. 165
Exhibiting: Consulting, design and development services for automation—including pneumatic, electronic, mechanical, and electrical equipment.
In attendance: J. N. Valbert, Pres.; Paul Allen, Treas. & Gen. Mgr.; John E. Smart, Sls. Mgr.; Frank Glomb, Chf. Engr.; Phillip Kaye, Frank Acton, Stf. Engrs.; John Ferkan, Adm. Engr.; Robert Hoffman, John Hoffman, William Shipman, Robert Highland, Herbert E. Edlund, Gil Outterson, George Schultz, Paul Fisher, George Tarizan, Reps.

BEEDE ELECTRICAL INSTRUMENT, Penacook, N. H. 408
Exhibiting: Small electrical panel meters.
See a d on page 1761

BENDIX COMPUTER DIV., BENDIX AVIATION CORP., Los Angeles 45, Calif. 445, 446
Exhibiting: New Products—Bendix Model G-15A General Purpose Computer; a stored-program, magnetic-drum computer for application to control systems, research, engineering, and production.
In attendance: Richard F. Walz, Sls. Mgr.; Vincent A. van Praag, Stf. Engr.; Frank M. Adair, Supv. Fld. Service; Alan L. Wolff, Sr. Sls. Engr.; S. Herbert Lewis, Stf. Mathematician; Max Palevsky, Sr. Mathematician.
See ad on page 1672

BERKELEY DIV. BECKMAN INSTRUMENTS, INC., Richmond, Calif. 139, 140
Exhibiting: New Products—EASE Automatic Computer to simulate

Exhibitors—continued

process control situation; Tape to electric typewriter data reduction system, plus the first instrument in a series representing a new concept in instrumentation. **Regular Products**—Industrial Control Systems; Analog Computers; Counters; Test and Nuclear Instruments; EPUTS; Frequency Meters; Digital Recorders; Scalers.
In attendance: Thomas Allinson, Div. Mgr.; Wallace Rianda, Asst. Mkt. Mgr.; C. E. Finnell, Prod. Line Mgr., Comp.; Carl Isborn, Sr. Proj. Leader; Joseph Hussey, Grp. Leader, Comp.; J. R. Cunningham, Sr. Systems Engr.; A. E. Young, Jr., Sls. Prom. Mgr.
See ad on page 1609

BOWMAR INSTRUMENT CORPORATION, Fort Wayne 4, Ind. 321
Exhibiting: New Products—360° Angle Counter Type 1502. **Regular Products**—Precision Servo Motor Gearheads; Precision Miniature Speed Reducers; Electro-mechanical Assemblies.
In attendance: E. A. White, Pres.; M. F. Dunne, Sls. Rep.

C. A. BRINKMANN & CO., Great Neck, N. Y. 227
Exhibiting: New Products—Automatic Weigh-Filling Machine (combining an accurate balance with automatic feed for granular materials or small screws, nut, etc.); Siemens Recording Camera (versatile 16-mm camera for continuous operation in recording at different distances, also suitable for time lapse work).; Automatic pH and Conductivity Controller and recorder (with novel types of "WIPER electrodes" "High Viscosity electrodes", etc.) **Regular Products**—Analytical and Micro Balances; Microscopes and Micro Cameras; Refractometers, Polarimeters, Flame Photometers; Paper-electrophoresis Equipment.
In attendance: Mr. C. A. Brinkmann; Robert Kinscherf; W. H. Kessel; W. Zeiler; H. H. Apt.

BURNDY ENGINEERING COMPANY, Norwalk, Conn. 225
Exhibiting: Connectors; plugs and jacks.

BYRON JACKSON DIV., BORG-WARNER CORP., Los Angeles 54, Calif. 215
Exhibiting: Vibratron digital pressure gage; Signal generators; Electronic measurement and control equipment.
See ad on page 1747

CHAINVEYOR CORPORATION, Los Angeles 22, Calif. 465, 466
Exhibiting: New Products—Combined power and free conveyor system weighing total of 5½ pounds per foot with 16" radius curves. Any type or length of system can be assembled from pre-fabricated components. **Regular Products**—Chainveyor—continuous powered overhead conveyor.
In attendance: P. T. Rauen, Pres.; L. F. Working, V. P.; W. H. Schilling, C. L. Long, R. G. Peterson, Lee Wood, Sls. Engrs.

C. P. CLARE & COMPANY, Chicago 45, Ill. 219
Exhibiting: New Products—Type "11" Stepping Switch, in one to eight levels of 11 contacts each, and operating voltages of 6 to 110 V.D.C.; Type "HG" and "HGP" Mercury Wetted Contact Relays having chatter free operation and 5-amp contacts. **Regular Products**—Relays; Sealed Relays; Stepping Switches; Lever Switching Keys; Push Keys and Turn Keys.
In attendance: D. R. Dooley, V. P.; E. H. Holt, Cent. Dist. Sls. Mgr.; W. F. Eich, Sls. Engr.; L. E. Noelck, Ass't. Sls. Mgr.; F. J. Wilmot, N. Krasowsky, Order Service; T. L. Sipp, Engr.
See ad on page 1579

CLARY CORPORATION, San Gabriel, Calif. 212
Exhibiting: New Products—Tape Punch Unit for creating a punch tape in any code up to eight channels; Electrical Output Adding Machine provides an electrical matrix capable of feeding into tape punch unit, tabulating card punches or other devices; Serial Entry Numerical Data Printer (adding machine capable of excepting pulses). **Regular Products**—Input Keyboards (10 key and full keyboards); Printing Timer; Time Data Printer; Parallel Entry Numerial Data Printer.
In attendance: Ken Oldenburg, Engr. & Supv.; Wm. R. Beall, J. N. Smith, Sls. Engrs.; Bryan Kuhne, Elec. Mech. Des.
See ad on page 1772

CLEVITE RESEARCH CENTER and BRUSH ELECTRONICS COMPANY, Cleveland 14, Ohio 451, 452
Exhibiting: New Products—Automatic Wire Wrap Machine for automatic wiring between terminals on chassis panel using wire wrap technique; TapeDRUM—a new type magnetic storage device; Datacord line of magnetic tape recorders and reproducers.
In attendance: BRUSH ELECTRONICS PERSONNEL—P. C. Smith, Mgr. Equip. Dept.; D. E. Pierce, Ass't. Mgr. Equip. Dept.; Myrle Burns, Mgr. Digital Dept. CLEVITE RES. CENTER PERSONNEL—J. H. Hosemann, Supv. Systems & Controls Sec.; A. D. Pendleton, Sr. Engr.—Systems & Controls Sec.; G. L. Hollander, Supv. Computers & Data Processing Sec.

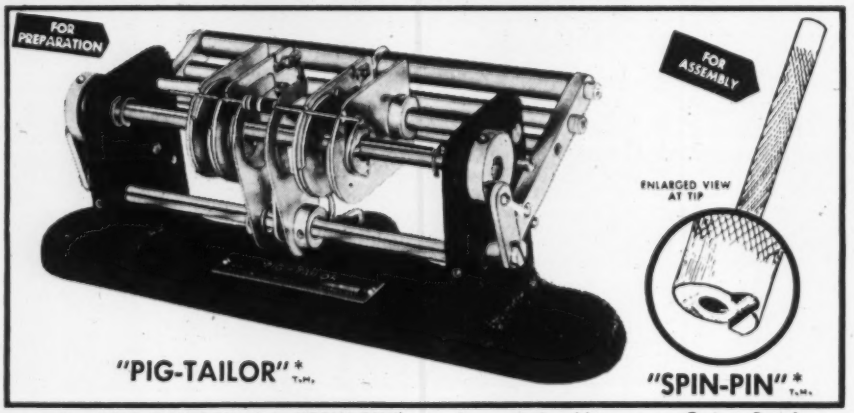
COLEMAN ENGINEERING COMPANY, INC., Los Angeles 15, Calif. 309
Exhibiting: New Products—Digitizers; three types (1) decimal, (2) binary, (3) binary coded decimal with various codes. All Digitizers receive rotating shaft inputs and convert these shaft positions into discrete electrical contact settings; they are used to operate data recording devices, such as printers, card and tape punches, typewriters, computers, etc. Accessory packages are available on a building block basis to supply the type of readout required from any Digitizers. **Regular Products**—Digitizers.
In attendance: Allen J. Edwards, Standard Prod. Mgr.; C. R. McKee, Liaison Engr.
See ad on page 1769

COMAR ELECTRIC COMPANY, Chicago 18, Ill. 440
Exhibiting: Relays, A.C. and D.C., open and sealed; Switches; Coils; Solenoids; Motors.
In attendance: E. F. Moloney, Pres.; E. F. Howe, Sls. Mgr.; Robert Valleau, L. Chocola, J. Bourque, D. Brunicardi, Wm. Auer, Engrs.; C. G. Anderson, Chf. Engr.; J. Walker, K. Schlauder, Sales.
See ad on page 1756

COMPUTER CONTROL COMPANY, INC., Wellesley 57, Mass. 452
Exhibiting: New Products—3C-BLOCs—Universal Building Blocks connected with patchcords to provide customer-designed digital control

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:
1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:
1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components.
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. IA10-P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

For more information circle **57** on inquiry card.

and computing systems. System design is simple and straight-forward. **Regular Products**—Special-purpose Digital Computer Systems; 3C-Acoustic Memory Systems; Crystal Controlled Pulse Marker Generators; Dual Beam Oscilloscope Conversion Units.

In attendance: Robert W. Brooks, Pres.; Robert E. Michaud; William P. Horton; Franklin R. Dean, Chf. Engr.; Benjamin Kessel.

COMPUTER-MEASUREMENTS CORPORATION, North Hollywood, Calif. **424**

Exhibiting: New Products—Single and dual preset counters for automatic counting and controlling in exact preselected quantities to 1,000,000 counts. **Regular Products**—Electronic counter-controllers, Totalizing counters, Frequency counter, RPM indicators, Universal counter-timers, Time interval meters, Decimal decade totalizers.

In attendance: J. K. Roundou, Pres.; E. C. Titcomb, Sls. Mgr.; C. E. Storie, Engr.; D. B. Pivan, Sls. Engr.

See ad on page 1759

CONTROL ENGINEERING CO., subsidiary of JERVIS B. WEBB CO., Detroit 4, Mich. **159, 160**

Exhibitng: New Products—L C Servo-Amp. (electronic automatic correction control package applied to equipment requiring precise control sensitive to motor load; Contact Relay—(low-voltage assembly used in place of limit switches). **Regular Products**—Testing Devices; Consoles; Control Panels.

In attendance: Vincent Kaye, Wm. M. Burr, James P. Kohls, Sls. Appl. Engrs.

WILLIAM C. COPP & ASSOC. (IRE ADV), New York 36, N. Y. **401**

Exhibiting: IRE Directory—Proceedings of the IRE; IRE emblems, pins, transactions, professional group applications. IRE information.

In attendance: William C. Copp, Exhibits & Adv. Mgr.; Scott Kingwill, Jr., Chicago Sls.; Lillian Petranek, Reservations Mgr.; Emily Petranek.

COUNTER and CONTROL CORPORATION, Milwaukee 14, Wis. **137**

Exhibiting: New Products—Programmonitors—revolution, stroke and electric counters for predetermining and automatically recycling multi-stage switching patterns. Electro-mechanical devices for complex switching requirements operating on a repeat cycle basis. **Regular Products**—Cyclo-monitors—Predetermined counters with instantaneous, automatic reset for continuous or intermittent recycling. Flexible controls which can be quickly set for constantly changing count requirements.

In attendance: Harold J. Geder, Secy.-Treas. & Gen. Mgr.; John W. Brown; Otto Riebe.

See ad on page 1660

CRAWFORD FITTING COMPANY, Cleveland 10, Ohio **107, 108**

Exhibiting: New Products—Swagelok fittings of zytel; Swagelok capillary tube fittings; Swagelok quick connect fitting; "Goop" thread lubricants. **Regular Products**—Swagelok Tube Fittings.

In attendance: F. A. Lennon, Pres.; A. P. Lennon, Treas.; D. P. Haag, Sls. Mgr.; E. E. Alto, Gen. Mgr.; E J. Zahuranec, Supt.; G. J. Moody, H. E. Lennon, Distributors; G. R. Malkin, Sls.

See ad on page 1685

DAGE TELEVISION DIV., THOMPSON PRODUCTS, INC. Michigan City, Ind. **132**

Exhibiting: New Products—Dage Model 60BR and Model 101-A Industrial Television Cameras for closed-circuit operation. Cameras provide means of observing remote or hazardous operations or for instructional purposes. **Regular Products**—Pan & Tilt systems; Remote Lens Change Turret; Remote-controlled Iris and Automatic Iris Control for Variable Lighting Conditions; Remote control of cameras over long distances. Accessories to adapt cameras to any application.

In attendance: John Howland, Gen. Sls. Mgr.; James E. Campbell, Industrial Sls. Mgr.; Charles E. Abney, Appl. Engr.; James L. Lahey, Gen. Mgr.; Joseph W. Alinsky, Chf. Engr.; Lyle Burrichter, Dist. Sls. Mgr.

See ad on page 1767

THE DAVIES LABORATORIES INC., Riverdale, Md. **226**

Exhibiting: New Products—Airborne Tape Transport, Series 541 (2400 ft. capacity); Airborne Tape Transport, Series 581 (1200 ft. capacity); Co-axial Magazine Loading Tape Transport. **Regular Products**—Airborne magnetic tape recording system, type 540; Miniature airborne magnetic tape data recording system, series 550; Laboratory tape data recording/reproducing equipment; Multi-track recording/reproducing heads.

In attendance: Gomer L. Davies, Pres.; Harriet L. Davies, Treas.; Joseph R. Schulman, Chf. Engr.; George B. Wetmore, Engr.

DESIGN TOOL CORP., New York 6, N. Y. **154**

Exhibiting: New Products—Lead-Former automatic pig-tail forming machine which fabricates leads of resistors and other components to desired shapes and specifications; Lead-Cutter automatic pig tail cutting machine that trims leads. **Regular Products**—Hand-Lead-Former; Lead-Straightener.

In attendance: Carl Kertesz, V.P.; Irving Kertesz, Chf. Engr.; Wallace Krakauer, Sec.

DIALIGHT CORP., Brooklyn 37, N. Y. **409, 410**

Exhibiting: Dial lights; Pilot lamps, assemblies.

See ad on page 1682

DOELCAM DIV., MINNEAPOLIS-HONEYWELL REGULATOR CO., Boston 35, Mass. **413**

Exhibiting: D-c indicating amplifier; Servo motors; Synchros; Gyroscopes.

See ad on page 1597

DU BOIS ENGINEERING & MFG. CORP., Hammond, Ind. **133**

Exhibiting: New Products—Panel Board. **Regular Products**—Water Cooler (Heavy Duty Industrial).

In attendance: M. A. DuBois, R. E. DuBois, Cy Carroll, F. C. Ohlander, Sls. Engrs.; Tom Lyon, Howard Sanders, Roy Appelquist, Elec. Engrs.

ALLEN B. DU MONT LABS., INC., Clifton, N. J. **447**

Exhibiting: Cathode-ray oscillographs; Cathode-ray tubes; Associated electronic equipment; Television control; Studio and transmitting equipment.

COMPRESSED AIR AND GAS COME OUT OF THE LOGAN

ARIDIFIER

Scrubbed CLEAN AND DRY

INSTALL ARIDIFIERS ON LINES SERVING

- Paint Spray Guns
- Air Tools
- Air Hoists
- Foundry Jolting Machines
- Sand Blasting Tools
- Sand Blasting Rooms
- Metal Spray Guns . . . or Wherever the line must deliver clean, dry air or gas

On any air or gas line 92% of the dirt, oil, scale and water that enter the Aridifier is trapped and removed from circulation. The Aridifier's patented centrifugal-baffle action scrubs air and gas clean and dry . . . protects equipment, prevents freezing, fouling, corrosion and caking, produces best results with spray gun and air tool operations, etc. Easy to install. Self cleaning. Maintains itself. 10 models available. Capacity 7 CFM to 17,000 CFM.

Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action.

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BOOST 100 PSI AIR PRESSURE TO 30,000 PSI FLUID PRESSURE

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$289.50

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Continuous-acting, air-driven. Various ratios give maximum fluid pressures of 100 to 50,000 psi. Size: 8¼" wide x 9⅝" deep.

Eight standard models. Special models for lower or higher pressures. Applicable wherever low-volume output at high pressures is the requirement, such as static testing, powering presses for forming, shearing, clamping, etc. Thousands in use. Complete power packages also available. Send for Bulletins.

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Engineering Corporation

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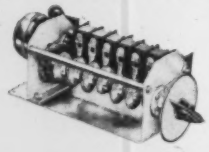
Be sure to see this modern

Zenith AUTOMATIC CONTROL EQUIPMENT

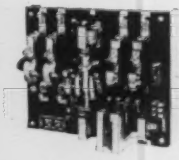
● 2ND INT'L. AUTOMATION EXPOSITION Nov. 14-17 . . . BOOTH 306 NAVY PIER—CHICAGO

ZENITH MULTI-CIRCUIT CYCLE TIMERS



Specially designed to accurately time any electrical operation. Set for on and off periods with as many circuits as desired. Furnished with synchronous motor for elevator control, limit switch, etc.

ZENITH AUTOMATIC TRANSFER SWITCHES

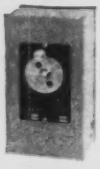


Automatic transfer to emergency source in 1/25th second . . . automatic return to normal voltage when restored. Supplied ac. or dc. Capacities up to 400 amps.

ZENITH INTERVAL TIMERS— MANUALLY PRE-SET

No clock springs to wind or break . . . powerful, self-starting, slow-speed, synchronous motor insures dependable operation. Timing ranges from 60 seconds to 72 hours. 115 and 230 volt models.

ZENITH RESET TIMERS— AUTOMATIC, REMOTE CONTROL



Easily pre-set, automatically reset. Synchronous motor opens and closes circuits as pre-set. May be used as timer in conjunction with standard start-stop push button station.

ZENITH PROCESS TIMER— with new PERCENTAGE CALIBRATION

For Hold Fire Control, Mixing Machinery, Testing Equipment, Fans, Heaters, etc. Wide variety of models for all types of adjustable automatic cycle timing. Total time cycle from 15 seconds to 24 hours, with range of adjustability to 94% for ON or OFF periods.

OTHER ZENITH AUTOMATIC CONTROL EQUIPMENT

—switches, contactors, motors, relays, solenoids, etc.—will also be on display. And all are illustrated and described in the valuable Zenith Catalog. Ask for your copy at the Exposition . . . or write direct today.

ZENITH ELECTRIC CO.
159 W. WALTON ST., CHICAGO 10, ILLINOIS

For more information circle **60** on inquiry card.

Exhibitors—continued

DYNAMIC GEAR CO., INC., Amityville, N. Y. 201
Exhibiting: New Products—Precision stock gears in medium and fine pitches, primarily for instrumentation. **Regular Products**—custom gears fabricated from supplied specifications.

EASTERN PRECISION RESISTOR CORP., Richmond Hill 18, N. Y. 214
Exhibiting: Decade boxes; Heat flow instrumentation; Resistors

EDER INSTRUMENT COMPANY, Chicago 14, Ill. 303
Exhibiting: Pocket microscope; Borescopes.
See ad on page 1754

A'G'A' DIV., ELASTIC STOP NUT CORP. OF AMERICA, Elizabeth, N. J. 228
Exhibiting: Time-delay Relays.
See ad on page 1758

ELECTRIC REGULATOR COMPANY, Norwalk, Conn. 434
Exhibiting: New Products—Automatic Motor Speed Control Equipment; Filament Regulator Equipment; Static Exciter Equipment; Combination Voltage-Frequency. Equipment. **Regular Products**—REGOHM regulator equipment for voltage, speed and tension control.
In attendance: W. H. Walter, Sls. Mgr.; M. S. Symon, Mgr. Government Eng.; A. W. Siff, Mgr. Chicago Office; L. F. Caruso, Appl. Engr.

ELECTRO SNAP SWITCH & MFG. CO., Chicago 24, Illinois 454
Exhibiting: New Products—J2-4 DPDT 4-circuit Hermetically-sealed Switch (environment-proof with a wide choice of circuit arrangements available; compact in size and rated 15 amps 125 v. a. c.). **Regular Products**—One way impulse switch; H-type hermetically sealed Switches; D88 type DPDT 4-circuit basic switch; S-type basic switch w/various actuators; E4 subminiature switch w/various actuators; Fire Control units for aircraft.
In attendance: Harold F. Ames, V. P. & Gen. Mgr.; John P. Barthell, Engr.; Eugene C. Connelly, Chf. Engr.; H. I. Anderson, Customer Serv. Mgr.; Jay Angel, Rep.

ELECTRIC INDICATOR COMPANY, Springdale, Conn. 210
Exhibiting: Signaling devices, Motors.

ELECTRONIC ASSOCIATES, INC., Long Branch, N. J. 149, 150
Exhibiting: New Products—Analog computer for solution of linear differential equations; Servo voltmeter; Analog voltage indicating device. **Regular Products**—Computers; Potentiometers; D-C plotting equipment; D-C converters; Arbitrary function generators.
See ad on page 1710

ELECTRONIC CONTROL SYSTEMS, INC., Los Angeles 25, Calif. 415
Exhibiting: New Products—Model C-100A Series Statistical Computers (specialized computer that prints out data in a 16-interval frequency distribution curve. **Regular Products**—Model M-94 Automatic Continuity Tester; Model M-115-200 Plug-in Decade Scaler; Model 115 Six-Channel Automatic Histogram Tabulator; Model 115B 12-Channel Automatic Statistical Analyzer.
In attendance: Jim Vrungos, Mgr. Government Contracts; P. R. Engels, Admin. Engr.; W. B. Broadwell, Eugene Hoo, Tech. Staff.

ELEMATIC EQUIPMENT CORP., Chicago 37, Ill. 316
Exhibiting: Pyrometers.
See ad on page 1758

ELGIN METALFORMERS CORP., Elgin, Ill. 161, 162, 163
Exhibiting: New Products—New EMCOR "FR-75" sloped front console. **Regular Products**—EMCOR Modular Enclosure System (line of over 200 consoles and components which enable design engineer to tailor-make his own console).
In attendance: James G. Wells, V.P.; Herb C. Golz, Chf. Engr.; Lawrence J. Fay, Robert Golz, Engrs.; S. K. Frankel, Pres.

ENCYCLOPEADIA BRITANNICA, Chicago 4, Ill. 443

EPSCO, INC., Boston, Mass. 151
Exhibiting: New Products—Epsco DATRAC reversible data reduction system. (50,000 samples per second; 0.05% accuracy). **Regular Products**—Lumped constant delay lines; Magnetic storage elements (frequency range of 10 to 200 kc); Pulse Transformers.
In attendance: Robert H. Sturdy, Sls. Mgr.
See ad on page 1647

ERIEZ MANUFACTURING COMPANY, Erie, Pa. 209
Exhibiting: New Products—Line of permanent magnetic equipment for conveying and controlling metal parts for automation operations. **Regular Products**—Magnetic Sheet Fanners; Magnetic Rolls for automatic feeding; Magnetic Conveyor for large and small metal objects.
In attendance: R. A. Roosevelt, Sls. Mgr.; Ned Hirt, Adv. Mgr.; W. W. Moyden, Dist. Sls. Mgr.; N. J. Chivas, D J. Burgess, Sls. Reps.

E-T-A PRODUCTS CO. OF AMERICA—Sales Div., Chicago 30, Ill. 323
Exhibiting: New Products—E-T-A Miniature Circuit Breakers (weight 1½ ounces, control current of 50 and 80 milliamperes. Up to 250 v ac, 24 v dc). A-P-S Starter Winding Relays (weight 1 ounce—with these devices starter winding cannot burn out, contains heat compensating circuit). Triplex, miniature breakers (full protection if any one of three phases is overloaded or short circuited). Temperature Sensitive & Time Relays with open & closed contacts. Etaphon Circuit Breakers (for protection of telephone circuit, with sign. relay). **Regular Products**—E-T-A miniature Circuit Breakers; M-R Motor Protection Relays; "Perlastic" Ceramic Insulation Tubing; ELPO Automatic Circuit Breakers.
In attendance: Felix Keller, Sls. Mgr.; Werner E. Heisig, Asst. Sls. Mgr.

FARRAND OPTICAL CO., INC., New York 70, N. Y. 319, 320
Exhibiting: New Products—Inductosyn systems for automatic control of machine tools and for other applications. **Regular Products**—Rotary Inductosyn; Linear Inductosyn; Miniature type packaged electronics for Inductosyn.
In attendance: J. L. Winget, Chf. Elec. Engr.; R. W. Tripp, Chf. Engr.; Vincent Foster, Elec. Engr.; D. A. Korman, Sls. Mgr.; Mr. C. L. Farrand, Jr., Tech. Serv. Engr.

FEEDBACK CONTROL, INC., Alexandria, Va. 453

Exhibiting: New Products—Multiplier Servo with zero-drift, 18-cps band width, adjustable error rate damping, and 0.1%-linearity follow-up and computing pots; Resolver Servo (performs rectangular to polar coordinate solution); Electro-mechanical integrator; Digital Voltmeter with 3 or 4 digit presentation. **Regular Products**—Gear trains; Electronic preamplifiers; Electronic Servo Amplifiers; Packaged servo-systems; Magnetic Amplifiers; Multiplier servo-systems; Magnetic Output stages; Arc-sine computers; Electronic booster Amplifiers; DIVIAC.

In attendance: Alexander Long, Pres.; W. Ronald Davies, V.P.; F. Eugene Somers, Mgr. Government Div.; David W. Patton, Sls. Engr.

FEMCO, INC., Irwin, Pa. 402

Exhibiting: New Products—Remote crane control; Crane Anti-collision Safety Warning System; Magnetic Limit Switch. **Regular Products**—Trolleyphone; Cranephone; Audio Systems; Carrier Control and Indication; Tone Control and Indication.

In attendance: W. P. Place, Pres.; N. F. Agnew, V. P.-Engr.; J. H. Loux, Chicago Sls. Engr.; J. W. Bauer, Pgh. Sls. Engr.; V. C. Holsinger, Jr., Gen. Mgr.

FERRARA, INC., Oak Park 37, Mich. 138

Exhibiting: New Products—TC On-off Timer (features cold cathode tubes and 20 ampere lead contacts); PRB2 Fail Safe Liquid Level Control (cold cathode circuit with both pump-in and pump-out applications); Ultra Sonic Paint and Conveyor Control (actuates spray or controls when object arrives at intersection of transmitter and receiver lobes). **Regular Products**—Electronic Timers for interval timing, timed delay, repeat cycling, programming and pulsing.

In attendance: Guido Ferrara, Pres.; Ralph Brengle, V. P.; R. O. Rheaume, Sls. Mgr.; Robt. Gardner, Sls. Repr.; D. E. Brewer, Adv. Mgr.

FISCHER & PORTER COMPANY, Hatboro, Pa. 256, 257, 356, 357

Exhibiting: Data Reduction and Automation Systems embodying digital techniques for plant operation at peak efficiency. **New Products**—Yield Computer; Multiple Flow Integration System; Industrial Telemetering and Supervisory System; Type P voltage Digi-Coder digital converter; New type automatic typewriter. **Regular Products**—Multiple Pressure Readout System; Automatic Data Logger; Digi-Coder shaft position digital converter; High accuracy instrumentation.

In attendance: Kermit Fischer, Pres.; Robert K. Stern, V. P. Data Reduction & Automation Div.; Robert Johnson, Midwest Div. Mgr.; Jack Roback, Chf. Proj. Engr.; Russell Bracegirdle, W. Martin Lyford, Donald Stephens, Howard Roseman, Automation Engrs.; Harry Sieg, Chic. Dist. Mgr.; James Moore, Bernard Artz, William Durkin, Fld. Engrs.; Warren Lauder, Exhibit Mgr.

FREED TRANSFORMER CO., Brooklyn 27, N. Y. 470

Exhibiting: Transformers

THE GAERTNER SCIENTIFIC CORPORATION, Chicago 14, Ill. ..121

Exhibiting: New Products—Popular priced Cathetometer (optical height gage); Creep Test Equipment. **Regular Products**—Toolmakers' Microscope; Linear, Coordinate and Angular Optical Measuring Equipment; Dilatation Interferometers; Spectroscopes and Spectrometers; Interferometers.

In attendance: Lyman W. Higgins; E. Gordon Watson; Paul F. Meyn; Dr. S. Jacobsohn; Frank Mauk; Mark Sobottke; Helge Jonsson.

GAUDREAU-RIMBACH ASSOCIATES, Pittsburgh 12, Pa. 173, 174

GENERAL PRECISION LABORATORY, INC., Pleasantville, N. Y. 439

Exhibiting: New Products—Industrial TV system using lightweight camera and plug-in unitized control elements. **Regular Products**—Industrial TV; accessories; and components.

See ad on page 1582

G. M. GIANNINI & CO., INC.,—DATEX DIV., Monrovia, Calif. 304

Exhibiting: New Products—Data Logging Systems; Analog to Digital Converter; Shaft Position and Coders; Data Recording Systems.

In attendance: John W. Bodnar, Sls. Mgr.; Jack D. Morrison, John P. Brogan, Fld. Engrs.; M. P. Odell, Sls. Rep.

RUSSELL T. GILMAN, INC., Janesville, Wisc. 231

Exhibiting: New Products—Air Transfer Slide-unit is adaptable where duel fixture tooling can be used. **Regular Products**—Standard Dovetail Slide Assemblies, Standard Spindle Assemblies.

In attendance: George W. Gilman, Jr., Sec.-Treas.; Russell T. Gilman, Pres.; Richard A. Buttke, Chf. Engr.

See ad on page 1670

GLOBE INDUSTRIES, INC., Dayton 4, Ohio 224

Exhibiting: New Products—New miniature electromagnet clutch and/or clutch brake; new miniature axial blower. **Regular Products**—Miniature and subminiature fractional HP DC, 400, and 60 cycle AC motors and motorized devices (motors, gear reducers, blowers, fans, vibrators, generators, switches, actuators, gyros, governors, and clutches.)

In attendance: Yale J. Holt, Sls. Mgr.; Aaron Sivitz, Chf. Engr.; Max Isaacson, Pres.; Walter Sparf, Leo Rusz, Tech. Fld. Reps.

GOODYEAR AIRCRAFT CORP., Akron 15, Ohio 135, 136

Exhibiting: New Products—GN-215 N3G, Servo Resolver; GN-215 N3J Dual Servo Multiplier; GN-215 N3L Servo Multiplier Resolver Generator; GN-215 L3L Relay Comparator. **Regular Products**—GN-215 L3 Linear Analyzer; GN-215 N3 Non Linear Rack; GN-215 N3A Electronic Multiplier; GN-215 N3E Function Generator; GN-215 N3D Servo-Multiplier.

In attendance: C. A. Meneley, Proj. Engr.; C. D. Morrill, Sr. Des. Engr.; J. A. Rudolph, K. H. Starks, Fld. Engrs.; T. R. Jakmides, J. A. Herrel, Stf. Reps.

LOREN F. GREEN & ASSOCIATES, Chicago 39, Ill. 210

GUARDIAN ELECTRICAL MANUFACTURING CO., Chicago 12, Ill. 455

Exhibiting: New Products—Solenoid Valve; Appliance Relay; Miniature Relay; 32-pole Relay; Power Relay; All Purpose Relay. **Regular Products**—All types relays; switches; solenoids; steppers; solenoid contactors; gun handles; cables; liquid level controls; fire control switch; complete control assemblies.

In attendance: D. O. Boucher, Adv. Mgr.; J. J. Rowell, Sls. Mgr.; F. F. Rowell, Jr., Pres.; G. G. Rowell, Asst. Sls. Mgr.; T. J. Obszarny, Chf. Engr.; M. Obszarny, Asst. Chf. Engr.; O. E. Johnson, J. Schmidt, W. Wright, Elec. Engrs.; C. M. Rowell, Service Engr.; A. L. Lassa, A. Steere, J. Gildo, L. Howard, D. Schuette, K. C. Williams, F. Nitti, R. Heyne, W. Rawson, V. Gennusa, K. Hawkins, S. Bank, C. Chilson, W. Schmidt, Sls. Engrs.

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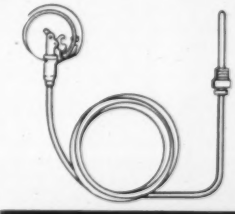

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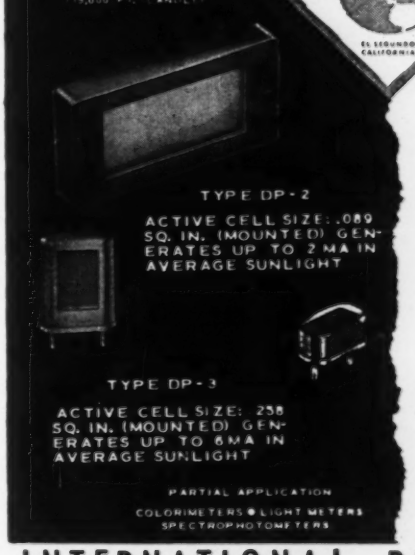
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Exhibitors—continued

W. & L. E. GURLEY, Troy, N. Y. 432, 433
Exhibiting: New Products—Binary Readout Systems. **Regular Products**—Surveying instruments; Wind instruments; Paper Testing instruments; Precision Patterns on glass.
In attendance: L. C. Higbee; R. G. Betts; M. S. Dickson; A. L. Mitchell.

HAMMARLUND MANUFACTURING CO., INC., New York 1, N. Y. 207, 208
Exhibiting: New Products—Pulse Count Unit—permits operator to dial-select up to ten points for control of ten functions; Pulse Count Follower providing a select-before-operate system. **Regular Products**—Audio-Tone Signaling Units; Duplex Signaling Units (DSU); Dual Transmitter Units (DTU); Dual Receiver Units (DRU).
In attendance: Frederick F. Sylvester, Gen. Sls. Mgr.; Leon C. Menkes, Asst. Sls. Mgr. Engr. Products; William Cunningham, Sls. Rep.; Robert L. S. Leedy, Adv. & Prom. Mgr.

THE HAYS CORPORATION, Michigan City, Ind. 460
Exhibiting: New Products—AMPTROL Motor Load Controller (used in material reduction processes to proportion mechanical load on a machine to the electrical load on the motor). **Regular Products**—Magno-therm O_2 Analyzer; Acratron Electronic Recorder; Electronic Flow Meter; Veriflow Positive Displacement Meter; Veritrol Rate of Flow Controller; Condu-therm Thermal-Conductivity Meter; Instrument Panels.
In attendance: Phil A. Sprague, Exec. V. P.; Orval Riggs, V. P.-Sls.; William Pugsley, V. P.-Fld. Res.; Paul LeBoeuf, Adv. Mgr.; Jack Tipton, Chf. Proj. Engr.; Clarence Miller, Daniel Meyer, John Heming, Proj. Engrs.; Edward O. Timm, Sls. Engr.; Karl Ziegler, Proj. Engr.; J. R. Nilson, Chf. Design Engr.
See ad on page 1625

THE A. W. HAYDON COMPANY, Waterbury 20, Conn. 403, 404
Exhibiting: New Products—Proportional-Delay Reset Time-Delay Relays (reset time vs delay time can be calibrated to match tube heating characteristics); Hermetically Sealed D. C. Stop Clocks; 5600 Series Chronometrically Governed D. C. Motors for 6, 12, 25 volt D.C. operation; Special Time Delay Relay (adjustable 0-30 seconds on 24-29 volts D.C.). **Regular Products**—D.C. Motors; Chronometrically Governed D.C. Motors; 400 Cycle Timing Motors; Repeat Cycle Timer; Elapsed Time Indicators; Time Delay Relays; Custom Designed Timers.
In attendance: R. J. Harrant, Sls. Mgr.; R. W. Perkins, Adv. Mgr.; F. Hoffman, P. Famiglietti, Sls. Engrs.

HEAT TIMER CORP., New York, N. Y. 216, 217
Exhibiting: Time-recorder-totalizer; time totalizer; electronic smoke control; electrically operated valves; electronic heat control; electronic fire alarm.
In attendance: Edward J. Zeitlin, Pres.; Lee Leighton, Chf. Engr.; Harry Zeitlin, V. P.; Al Abraben, Adv. Mgr.; Al Fowler; Howard Berger; B. Josephson.
See ad on page 1647

KARL HEITZ, INC., New York 17, N. Y. 444
Exhibiting: New Products—Projectina; Kern Swiss Super-Stroboscope; Kern Swiss Prismatic Binocular Microscopes, Bleeker Research Microscope R; ALPA Camera. **Regular Products**—DIAX 35 mm Camera; Bleeker Microscope K; Bleeker Phase Contrast Microscope S; Bleeker Pocket Spectroscope; Kern Swiss Prismatic Binoculars.
In attendance: Karl Heitz, Pres.; Margaret Connely, Asst.; A. W. Paulson, Sls. Rep.

HOKE, INC., Englewood, N. J. 109, 110
Exhibiting: New Products—New series brass packless Bellows Valves redesigned for longer operating life; new Well Chart for piping system designers and storekeepers. **Regular Products**—Needle Valves; Toggle Valves; Packless Values stainless steel Cylinders; Flo-gages.
In attendance: W. O. Teeters, Pres.; D. B. Salmon, V. P.; E. B. Hitchcock, Sls. Mgr; W Calahan; Greg Moody, Harry Lennon, L W. Loyen, Guy Speaker, Sls. Reps.

HOWARD INDUSTRIES, INC., Racine, Wisc. 414
Exhibiting: New Products—Model 9200, Distributed Wound Induction Motor in horsepower range of 1/15 to 1/100; Model 3700 for low operating temperatures, is most powerful motor in its frame size presently being produced in the fractional-horsepower field (up to 2 hp). **Regular Products**—Frac-hp motors—Universal AC-DC Type, Shaded Pole Type, and Induction Motor Type; also line of speed reducers.
In attendance: Mr. Fremont Fisher, Sls. Mgr.; Mr. Norm Schmidt, Mr. Jack Lee, Mr. E. C. Spaay, Mr. R. Jones, Sls. Engrs.

HYCON MFG. COMPANY, Pasadena 8, Calif. 101, 102
Exhibiting: New Products—Hycon Model #625 Digital Ratiometer (a fully automatic self-balancing instrument with a direct readout; reads the ratio of two related d-c voltages on a three-digit high-speed counter). **Regular Products**—#625 Digital Ratiometer; #615 VTVM Digital; #614 Vacuum Tube Volt Ohmmeter; #617T 3-inch Oscilloscope; #616 Color Bar/Dot Generator; #622 5-inch Oscilloscope; #6152 Digital Counter Unit; TS/230 Power Meter; OS8A/U Military Oscilloscope.
In attendance: Alden E. Acker, Pres.; Jim Norman, Asst. Sls. Mgr.; A. H. Bruning, Chicago Sls. Rep.; John Thompson, Sls. Mgr.; Don Downie, Public Relations Dir.
See ad on page 1673

INDUSTRIAL CONTROL PANEL CO., Chicago 6, Ill. 315
Exhibiting: New Products—Beacon Tower Lighting Control Panel for control of microwave tower beacon lights; provides all safety and alarm features required by CAA. **Regular Products**—Automatic Power Transfer Panels; Load Demand Type Panels; Drying Oven Control Panels; Oil-Well Pumping Control Panels; Test Panels; Process Control Panels, Batch Control Panels; Sequence Control Panels; Differential Control Panels.
In attendance: Henry A. Hart, Chf. Engr.; Merl W. Richman, Sls. Mgr.; E. B. Henderson, Sls., St. Louis; Lora Portis, Public Relations.
See ad on page 1698

INDUSTRIAL TIMER CORP., Newark 5, N. J. 331, 332
Exhibiting: New Products—Time base programmers. **Regular Products**—Interval timers, time-delay timers, running time meters, tandem recycling timers, multi-cam timers and percentage timers.
In attendance: L. L. Neidenberg, R. A. Rossney, F. G. Corbett, B. Volin and K. P. Kraemer.

INSTRUMENT DEVELOPMENT LABORATORIES, INC., Needham Heights 94, Mass. 213
Exhibiting: New Products—High Speed Rotary Switching Devices (motor driven, multiple wafer sequencing switches); Shaft Digitalizer (small, high performance, electro-mechanical digitalizer, featuring 20 ma current capacity, digitizing shaft angle to 0.1 degree or 0.1 minute); Color-Eye, Model C (new model precision color comparison instrument for industrial color measurement); Colorede Process Control Unit (sensitive light comparator). **Regular Products**—60-cycle Rotary Synchronous Chopper.
In attendance: Fed H. Gerring, Mgr. Customer Relations; George P. Bentley, Pres.

INSTRUMENTS PUBLISHING COMPANY, Pittsburgh 12, Pa. 464
Exhibiting: Publications—"Instruments & Automation" and "Instrument & Apparatus News". Buying Directory—"The Instruments and Automation Catalog and Index" Books.

INTERNATIONAL BUSINESS MACHINES CORP., New York, N. Y. 143, 144
Exhibiting: Electronic computers; Data Processing Machines.

INTERNATIONAL STANDARD TRADING CORP., New York 6, N. Y. 311, 312
Exhibiting: New Products—Teleprinter equipments designed as computer elements; Electronic telegraph switching systems with multiple inputs to computers and for communications purposes; Gas tubes and diodes for computers; Automatic Pneumatic Selective Tube systems for transmission of documents, samples, punched cards etc. with supervisory controls. **Regular Products**—High speed relays; Rotary-step and other telephone type switches; Interconnecting telephones; Switching systems; Moly-permalloy dusts; Permalloy cores; Message registers; Counters.
In attendance: J. T. Benjamin, Sls. Mgr. & V. P.; M. Bakst, Sr. Engr.; E. O. Campbell, Engr. of Installations; W. Stieber, Proj. Engr.

JAMES VIBRAPOWR COMPANY, Chicago 18, Ill. 314
Exhibiting: New Product—Instrument DC/AC chopper. **Regular Products**—Vibrators, Portable power supplies; Transformers.
In attendance: John A. Kennedy, Pres.; Robert C. Canning, V. P.; P. T. McCauley, Dir. Engr.; G. W. Plice, Chf. Engr. Spec. Prod.; J. H. Quigley, Chf. Engr. Vibrator Prod.; L. Smith, Sls.

JOY MANUFACTURING CO., St. Louis 10, Mo. 324
Exhibiting: New Products—Electrically heated cable-vulcanizer with two 50-watt heaters for rubber, synthetic, or plastic jacketed cables. **Regular Products**—One-piece moisture-tight electrical connectors; Neoprene/rubber incased precision switches; Lamp sockets; Cable vulcanizers.
In attendance: R. E. Campbell, Sls. Prom. Dir.; F. A. Bartosh, St. Louis Sls. Prom. Mgr. Asst.; J. Gould, C. Howard, Special Distributor —Howard & Gould Co.; R. E. Kinter, Asst. Sls. Prom. Mgr.; G. D. Miller, J. E. Saxe, Sls. Reps.; J. Y. Richards, Dist. Sls. Mgr. Chicago; C. E. Thorup, Sls. Prom. Mgr. St. Louis; H. B. Zeppenfeld, Sls. Mgr. St. Louis.

KAY ELECTRIC COMPANY, Pine Brook, N. J. 210
Exhibiting: Electronic instruments.

KAYE DEVELOPMENT CO., Stamford, Conn. 458
Exhibiting: Trichrometer—continuous color process control.

KLEINSCHMIDT, INC., Deerfield, Ill. 420
Exhibiting: Page teleprinter; Typing reperforator and tape transmitter; Tape transmitter.

KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago 3, Ill. 103, 104
Exhibiting: New Products—Multi-Digit Pre-determined Decade Counter (relay-type counting device, designed around Kellogg Magnetic Impulse Counter); Magnetic Latch Key (push-button switch with magnetic hold). **Regular Products**—Crossbar Switches; Relays; Magnetic Impulse Counter; Lever Switches.
In attendance: R. Rosenkoetter, Ind. Sls. Engr.; R. H. Williamson, Mgr.-Ind. Sls.; O. J. Berger, Jr., C. A. Brendel, R R. Meridith, Sls. Reps.; E. Leonard, Systems Engr.; J. Boda, Relay Engr.; J. G. Beckley, Mgr.-Elec. Sls.; H. F. Van Zandt, Asst. Sls. Mgr.

KULKA ELECTRIC MFG. CO., INC., Mount Vernon, N. Y. 328
Exhibiting: New Products—Subminiature power outlets with solder terminals or leads; Kliptite terminal blocks with tabs to fit standard female connectors such as made by amp. **Regular Products**—Molded terminal blocks, toggle switches to meet government specs. Terminals; power outlets; convenience outlets; sockets; receptacles, cord sets, candelabra and intermediate sockets; lampholders; lugs; market strips; laminated type terminal blocks; electrical wiring devices.
In attendance: Eugene R. Kulka, E. E., Pres.; William Kulka, Treas. (Sls. Mgr.); Rudy Hanke, Frank Hanke, Bill Rice, Sls. Reps.

J. B. LANSING SOUND INC., Los Angeles, Calif. 210

LARSON INSTRUMENT COMPANY, Terrytown, N. Y. 318
Exhibiting: New Products—Inkless Recorders (up to 30 styli). **Regular Products**—Excess-Variation Recorder; Contact Type Controllers; Inkless Recording Equipment; Temperature Controls; 30-channel Inkless Recorder; Time Recorder with Totalizer; High Speed Electronic Contact Meter; High Speed Recorder and Controller; Smoke-Dust Indicator Control; Central Control System; Voltage Breakdown Tester (mobile).
In attendance: Louis H. Larson, Chf. Engr.; William H. Henshaw, Gen. Sls. Mgr.; James Everett, John Parker, James Jackson, John J. Servatius, Ed Kirschner, Sls. Engrs.; G. Adam, Asst.

LEHIGH CHEMICAL COMPANY, Chestertown, Md. 116
Exhibiting: New Products—Permanent Lubrication (lubricants approaching permanent lubrication); Thixotropic Oils (lubricants with handling properties of oil and film characteristics of grease). **Regular Products**—Lubricating oil; Grease; Damping fluid; Slushing compound; Additives; Greases resistant to acids, solvents or water; Metal cleaners; Degreasing solvents; Emulsion cleaners.
In attendance: C. David Haacke, Sls. Mgr.; H. G. Gruber, Chf. Chem.; Wm. Cassanos, Roland S. Lee, Sls. Reps.

G. H. LELAND INC., Dayton 2, Ohio 462
Exhibiting: New Products—Hermetically sealed relays; BD2 Sub-

miniature relay. **Regular Products**—Ledex rotary solenoids; Ledex selective and stepping relays.

In attendance: James R. Dunbar, Sls. Engr.; George B. Isaacs, Fred M. Pummill, Sls. Dept.; Jim Bierhaus, E. A. Dickinson, John Dickinson, Sls. Rep.; Gerald Leland, V. P. & Gen. Mgr.; Hans. G. Belitz, Sls. Mgr.

LIBRASCOPE, INC., Glendale 1, Calif. 437, 438

Exhibiting: New Products—Electronic general-purpose Digital Computer—the LGP-30 (a serial, one-address, fixed binary point, stored-program, magnetic-drum computer designed to handle large-scale scientific and engineering calculations); Pressure-compensated Totalizing Flow Computer for gases to operate directly from the differential and pressure elements. **Regular Products**—X-Y Plotter & Recorder; Analog-Digital Converters; Read Record Heads; Ball & Disc Integrator; Differentials; Sine-Cosine Mechanism.

In attendance: K. J. Slee, Sls. Mgr.; J. L. Cass, Dr. S. P. Frankel, W. L. Chase, Comp. Engrs.; E. W. Silvertooth, J. Everett, Sls. Engrs.; W. Reinholtz, Comp. Engr.

See ad on page 1583

LOGISTICS RESEARCH, INC., Redondo Beach, California 442

Exhibiting: New Products—Alwac III-E digital computer with 4,096- or 8,192-word magnetic drum, two instructions per word, with automatic address modification, paper tape, typewriter, punched cards, magnetic tape. **Regular Products**—Alwac III digital computer.

In attendance: W. V. Neisius, V. P.; D. D. Britton, Appl. Engr.; V. White, Fld. Serv. Mgr.; S. Philips, Fld. Service Engr.; R. B. Whitney, Appl. Engr.

See ad on page 1706

L & O RESEARCH AND DEVELOPMENT CORPORATION, Wayne, Pa. 326

Exhibiting: New Products—Automatic Transmission Measuring System (records the frequency transmission of a network from 30 cycles to 150 kilocycles; Graphical Numerical Recorder (prints a graph of large dimensions on ordinary adding machine tape; through use of multiple traverses, prints a record of number of traverses made).

In attendance: A. F. Cary, Pres.; William H. Deily, Chf. Elec. Sec.

MAGNECRAFT ELECTRIC COMPANY, Chicago 7, Ill. 117

Exhibiting: Relays.

MAGNETIC RESEARCH CORP., El Segundo, Calif. 441

Exhibiting: New Products—Model MR-300-1C Magnetic-Computer-type Power Supply—Dual Magnetically Regulated A.C. Line Transients are eliminated by an all-magnetic Line Regulator. The second magnetic amplifier regulates the output voltage with respect to load changes. Offers .1% static regulation. 1% dynamic regulation. **Regular Products**—"Magnestat" Magnetic Servo Amplifiers; "Magnepulse" Magnetic Pulse Generators; "Micromag" Magnetic DC Signal Amplifier (low level); "Stablvolt" Magnetic DC Power Supplies; Magnetic AC Line Regulators.

In attendance: Harry Remer, Sls. Mgr.; Dr. Hugo Woerdemann, Pres.; Hugh Marsland, Rep.

MAXSON INSTRUMENT DIV. OF W. L. MAXSON CORP., Long Island City, N. Y. 327

Exhibiting: New Products—Alternator Regulator—a magnetic-amplifier voltage regulator designed for controlling a 3.75-KVA 3-phase 208-400cps alternator; Statistical Accelerometer—records on direct reading electromagnetic counters the number of times four specific acceleration levels have been experienced by the article to which the accelerometer is attached; Ultrasonic Flowmeter—for volumetric and gravimetric flow rates and totalization with no obstructions in pipe. **Regular Products**—Precision Phasemeter with incremental accuracy of 0.01° from 30 to 20,000 cps; Inverter Frequency Regulator—regulates frequency of 2.5 KVA inverters to 400 ±1.0 cps; Subminiaturized I-F Amplifiers—30, 60, & 90 mcs; UHF Wideband Power Oscillator (200-2500 Mc) with power output of 40 w.

In attendance: C. D. Berger, Sls. Mgr.; W. Krum, Chf. Engr.; L. T. Donnelly, Adm. Asst.; R. N. Evensen, Appl. Engr.; W. E. Thresher, Sls. Rep.; F. H. Rohrig, Gen. Mgr.

MECHANICAL DIV. OF GENERAL MILLS, INC., Minneapolis 13, Minn. 435, 436

Exhibiting: New Products—"Autofab" automatic electronic assembly machine which assembles components to printed circuits at 10,000 assemblies a day.

In attendance: G. O. Haglund, Dir. Sls.; D. J. Owen, Mgr. Sls.; Philip Christopherson, Asst. Chf. Engr. Engr. Res. & Dev.; Al Driscoll, Mgr. Equip. Sls.; Edmund E. Johnson, Adv. Mgr.

MECHANICAL HANDLING SYSTEMS, INC., Detroit 12, Mich. 155, 156

Exhibiting: IVC Drive with Magnetic Amplifier Control; Multi-Ratio Silent Reducer; Overlimitor; Standard conveyor components including Junior 3", 4" and 6" Monoveyors; Standard components including 4" x 4" and 6" x 4" Power and Free components and Sub-Floor Tow Conveyor section.

In attendance: L. J. Bishop, V. P.; P. Youngdahl, Res. Engr.; G. B. Gray, W. D. Stevens, J. P. Massimiani, Sls. Engrs.; D. Bolle, Standards Engr.

METROTYPE CORPORATION, Michigan City, Ind. 461

Exhibiting: New Products—Metrotype digital recording systems to collect data relative to almost any variable automatically, and convert and record it numerically. **Regular Products**—Analog-Digital Conversion, Telemetering; Load Control; Numerical Recording.

In attendance: Edgar M. Corson, V. P.-Sls.; George Foster, V. P.-Engr.; Lawrence Keenan, Regional Mgr.

MICRO SWITCH, DIV. MINNEAPOLIS-HONEYWELL, Freeport, Ill., ... 152, 153

Exhibiting: New Products—Illuminated Push-Button Switch (miniature bayonet lamp inside head of push button); Small 2-circuit Limit Switch (roller arm actuator head is field adjustable); Environment-proof Subminiature Switches (trouble-free operation in a temperature range of from −65 to +180°F). **Regular Products**—Limit switches; Safety switches; Push-button switches; Toggle switches; Subminiature switches; Aircraft switches.

In attendance: Nick Kouzmanoff, Mgr.—Central Area; H. E. Hawkins, C. J. Kremer, R. R. English, E. R. Sparks, I. F. Glosup, R. Rickey, T. G. Funk, Fld. Engrs.; F. E. Wilsey, Gen. Sls. Mgr.; J. K. Lincoln, E. Sls. Mgr; R W. Sandstrom, Adv. Dept.; D. H. Brubaker, Adv. Mgr.

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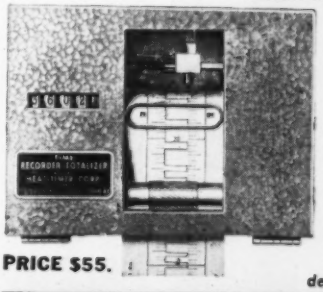

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Now a brand new ultra-high-speed reversible data converter ... DATRAC ... automatically translates voltages to digital data or reverses the process.

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Exhibitors—continued

MYCALEX CORPORATION OF AMERICA, Clifton, N. J. 407
Exhibiting: **New Products**—Supramica 500 (permits operation at temperatures up to 1000°F; maintains thermal endurance above the range of organic insulating materials). Supramica 555 (capable of being precision molded, offers thermal endurance up to 950°). Synthetic Mica (Synthamica) for appliance terminals, allows water emmersion of kitchen appliances. Printed and etched circuits. **Regular Products**—Mycalex—410, 400, 410X, KM and K glass-bonded mica, Commutation Telemetering Switches; Mycalex Tube Sockets; Commutator Plates.
In attendance: Kenneth Tindall, Mgr. Pacific Div.; Richard Hall, Comm. Engr.

NASH ENGINEERING COMPANY, South Norwalk, Conn. 129, 130, 131
Exhibiting: Air compressors for automation.
See ad on page 1628

THE NATIONAL CASH REGISTER COMPANY, Dayton 9, Ohio 427, 428, 429
Exhibiting: Standard Class 31 Accounting Machine; 142A Payroll Machine; 126 Magnetic Tape Unit.
In attendance: J. E. McDade, Mgr. Electronic Sls.; Dr. Daniel Teichroew, Sr. Elec. Appl. Spec.; C. K. Shoys, M. F. Harris, Elec. Appl. Spec.

NORTH AMERICAN AVIATION, INC., Los Angeles 45, Calif. 422, 423
Exhibiting: NATPAC—general-purpose programmed automatic computer; NADAR—crash-proof airborne tape recorder and associated playback; Self-balancing Potentiometer for aircraft flight instrumentation. NATECS—electronic emergency traffic control system.
In attendance: D. S. Grant Brooks Van Hauten, A. F. Krueger, Lee Amedt.

NORTH AMERICAN MANUFACTURING CO., Natick, Mass. 125
Exhibiting: **New Products**—"Protomaker" (portable laboratory designed to manufacture printed-circuit prototype). **Regular Products**—Printed Circuits.
In attendance: H. E. Jones, Pres.; Richard G. Zens, Gen. Mgr.; John M. Falla, Sls. Mgr.

NORTH AMERICAN VAN LINES, INC., Fort Wayne, Ind. 469
Exhibiting: Exhibit booth transportation and care.
In attendance: Harold S. Bechert, Mgr. Industrial Sls.; Miss Marion Childs, Mr. Ben Mundkowsky, Mr. Stuart Lowe, Sales.

NORTH ELECTRIC MFG. CO., Galion, Ohio 145, 146
Exhibiting: Remote & supervisory equipment; electronic components.

OPTRONICS, Inglewood 2, Calif. 325
Exhibiting: **New Products**—Electronic Autocollimator—optically measures minute angular changes (half second to half degree). Azimuth and elevation angular changes read directly on panel meters and DC voltages (25 MV/sec) available for automation applications.
In attendance: Oscar Falcon, Pres.

PAK-RAPID, INC. West Conshohocken, Pa. 308
Exhibiting: "Pak-Rapid" Automatic Packaging Equipment.
In attendance: James Irvine, Pres.; Benjamin Karpowicz, V. P.; Samuel B. Vrooman, Sec.; John J. Coakley.

PANELLIT, INC., Skokie, Ill. 111-115
Exhibiting: **New Products**—Information systems that automatically log process conditions, continuously monitor variables, provide signal and readout. **Regular Products**—Annunciators. Complete centralized-control centers, including graphic panels for process control.

PEDERSEN ELECTRONICS COMPANY, Lafayette, Calif. 210

PIC DESIGN CORP., Lynbrook, L. I., N. Y. 204
Exhibiting: **New Products**—Precision breadboard servo kits for engineering and development work and all electronic mechanical applications. **Regular Products**—Precision instrument components complete from stock (shafts, collars, couplings, gears, differentials, speed reducers, breadboard parts).
In attendance: Wimfred M. Berg, Pres.; Rowland Schwenker, V. P.; Leroy W. Beier, Sls. Rep.

POLARAD ELECTRONICS COMPANY, Long Island City, N. Y. 210
Exhibiting: Remote control equipment.

POST MACHINERY COMPANY, Beverly, Mass. 222, 223
Exhibiting: Electronic counters and controls.

POTTER & BRUMFIELD, Princeton, Ind. 305
Exhibiting: Electric relays—all types—all sizes for all applications.
In attendance: R. M. Brumfield, Pres.; Dale V. Cropsey, V. P.; C. J. Dorr; Zeke Smith; D. L. Sisson; H. A. Turner.

POTTER INSTRUMENT CO., Great Neck, L. I., N. Y. 134
Exhibiting: **New Products**—Magnistors—small saturable reactors used to control electrical pulses or sine waves in frequencies of 100 kc to 30 Mc. Magnistors can gate, switch amplify, count and register, as well as form logical arrays for adding, subtracting, shifting and other computing functions; Model 903 Perforated Tape Reader with reading speeds of 600, 300 or 150 per second, 5 millisecond start time, stops on a character; 5, 6, 7, or 8 channels. Servo-controlled reel-drive Motors; Magnetic Digital Recording Heads that eliminate "digit drop-outs" thru use of high accuracy machined all-phosphur bronze head mounts. **Regular Products**—Model 902 Magnetic Digital Tape Handler; Model 564 Preset Interval and Delay Generator; Model 432 Counter Chronograph; Model 840 Frequency Time Counter.
In attendance: John J. Wild, Sls. Mgr.; John B. Flynn, Sls. Engr.; Edward Stemm, Sls. Rep.
See ad on page 1705

PRECISION SCIENTIFIC CO., Chicago 47, Ill. 220, 221
Exhibiting: **New Products**—Automatic Distillation Apparatus (ASTM D 86 repetitive distillations of petroleum products; automatically plots distillation curve, initial boiling point, end point); Automatic Reid Vapor Pressure Recorder (monitors motor gasoline blending. Correlates with ASTM D 323); Automatic Loading Rack Flash Point Tester (for "go-or-no-go" flash testing of distillate fuel at bulk distributing points; operated by truck driver); Precision-Dow Dual Recordomatic Titrometer (for opaque solutions impossible for colorimetric titrations, multiple end-points. Titrates within five minutes.); Precision-Shell Dual Titrometer (two diverse titrations simultaneously.)

PRINTED ELECTRONICS CORPORATION, Natick, Mass. 125
Exhibiting: Portable laboratory to manufacture printed circuit prototypes.
In attendance: H. Eugene Jones, Pres.; Richard G. Zens, Gen. Mgr.; John M. Falia, Sls. Mgr.

PRODUCTION INSTRUMENT COMPANY, Chicago 6, Ill. 124
Exhibiting: **New Products**—PIC-600 Electric Counters (50,000,000 count life rating, 1000 counts per minute, 7 watt power consumption); PIC Dozens Counters (counts and records dozens counted. **Regular Products**—Super-Wizard Electric Counters; Mercury Electric Counters; Actuating Switches for Electric Counters; Monitor Automatic Batch Counters; Silver King Stroke & Revolution Counters; Junior King Stroke Counters; SMX Stroke Counters; Clipper Coil Winding Ctrs.; Tape Recorder Counters; Telephone Message Ctrs.
In attendance: Paul L. Poole, Pres.; Jos. F. Visin, V. P. -Sls. Mgr.; R. J. Visin, Ass't. to Pres.; R. J. Marlatte, Plant Mgr.; J. A. Tyska, J. R. Gaudry, Jos. H. Woolf, Sls.; B. Wollar, Geo. Burry, Engrs.

RADIO FREQUENCY LABORATORIES, INC., Boonton, N. J. 229, 230
Exhibiting: **New Products**—Model 983 "Voicon" Voice-plus-Control terminals for use on wire lines, microwave or power line carrier; Model 591 Frequency Meter (125 Kc to 1000 Mc) with accuracy of 0.005%. **Regular Products**—"Comvor" data transmission terminals for telemetering and supervisory control; AC-DC instrument calibration standard; Magnet Charging and Magnet Treating equipment; Chassis slides; "Sealnuts"; Handles for cases.
In attendance: Robert H. Denton, V. P.; Henry H. Emker, Appl. Engr.; David S. Kromka, Sls. Mgr.-Test & Service.

J. B. REA COMPANY, INC., Santa Monica, Calif. 412
Exhibiting: **New Products**—READIX—a general-purpose low-cost, medium-speed digital computer for business data processing, scientific computation, industrial control, data reduction. **Regular Products**—Robey Rotor miniature motors and gyros; Autopilots; Cruise Controls; Helicopter hovering controls; Reatherm Surgical Cold Blanket.
In attendance: Lloyd Schumacher, V. P.; Russell LeVesque, William McGuckin, Richard Davis, Customer Relations; Jim Mitchell, Richard Russell, Proj. Engrs.

REPUBLIC MFG. COMPANY, Cleveland 11, Ohio 233, 234
Exhibiting: **New Products**—Lo Torq High Pressure Selector Valves for 6000 psi service; Gage Protectors which cut out gage when pressure rises above setting. **Regular Products**—Industrial and Aircraft Valves—Needle, globe, relief, etc.
In attendance: George Goecke, Sls. Engr.; F. C. Atack, Sls. Mgr.; A. O. Bates, Pres.; Frank Hribar, Sls. Engr.; A. M. Burgh, M. Siskin, A. J. Reilly, V. J. Sloma, J. P. Murphy, Flow Products Co. (Distr.); Frank Lammers, Arnold Johnson, W. J. Farrell, Steve Hobbs, Wallace Tube Co. (Distr.).

REVCO INCORPORATED, Minneapolis 4, Minn. 232
Exhibiting: **New Products**—Model 143 Zero Max Variable Speed Reducer (torque rating 30-in-lbs, maximum 1/3 hp); Model 24 Zero Max Variable Speed Reducer (100-inch-lbs torque; maximum 3/4 hp); Zero Max "G-R" series (gear reduction); Tork-O-Stat overload protector (mechanical slip clutch); Gear-O-Mat gear reducer (reduction ratios through 5 to 1 and hp through 1/2 lp). **Regular Products**—Zero Max Variable Speed Reducers (1/30 through 3/4 hp; instant reverse and instant neutral).
In attendance: Richard G. Gray, Pres.; Richard A. Hersey, Sls. Engr., Revco factory; D. C Batterson, Dist. Rep.

SAFFRO-GETTLEMAN CO., Chicago 10, Ill. 408
Exhibiting: **New Products**—Universal Magnetic Test Set. Complete test set-up for magnetic lamination tests following ASTM specifications. Wattmeter of 1/10th percent accuracy. Lab Standard. **Regular Products**—Electrical instruments of 5% accuracy AC and DC; Electrical instruments of 2% accuracy DC only; Portable, lab and test instruments with accuracies to 1/20th%; Variable transformers; Inverters; Vibrators.
In attendance: Yale L. Saffro, Marv Gettleman, Partners; Jay Mages, J. Bobera, H. Miller, Slsmen.

THE SCAM INSTRUMENT CORP., Chicago 18, Ill. 158
Exhibiting: **New Products**—Du-All annunciator; a single relay annunciator system that provides a flashing sequence with audible signal and automatic return to normal. **Regular Products**—De-Line annunciators systems; S-line annunciators systems; Explosion Proof annunciators systems; Remote annunciators systems.
In attendance: Cary Wilson, Pres.; Howard Warren, V. P.; Thomas Mitsos, Engr.

SENSITIVE RESEARCH INSTRUMENT COMPANY, Mt. Vernon, N. Y. 408
Exhibiting: Small electrical panel meters; Electric test instruments; Laboratory Standard instruments.
See ad on page 1572

SIMPSON ELECTRIC COMPANY, Chicago 44, Ill. 128
Exhibiting: **New Products**—383 In-Circuit Capacitor Leakage Tester; 388-3L Term-O-Meter; 458 7" Colorscope; 434 Varidot Generator; 397 Line-O-Meter. **Regular Products**—1000 Tube Tester; 479 TV-FM Generator; 260 AC-DC Volt-Ohm-Milliammeter; 303 Vacuum Tube Volt-Ohmmeter; Panel meters—1", 2½", 3½", 4½", 5½".
In attendance: Pete Papas, Ted Franks, Slsmen; Bob Middleton, Engr.; Dudley A. Hansen, Fld. Engr.; M. O. Buehring, Sls. Mgr.; Al Arbeiter, Engr.; Jack Whiteside, Mgr.; Larry Patterson, Joe Cubert, Production.

SORENSEN & COMPANY, INC., Stamford, Conn. 210
Exhibiting: Regulators; Transformers; Power Supplies.
See ad on page 1595

SOROBAN ENGINEERING, INC., Melbourne, Fla. 313
Exhibiting: **New Products**—Keyboard-Punch (a Soroban Coded Keyboard and a Commercial Controls Paper-Tape Perforator for preparing 7-channel data tapes); Tape Comparators (compares two perforated paper tapes and stops whenever the characters sensed on the two tapes are not identical). **Regular Products**—Coded Keyboards; Paper Tape

Readers; Automatic Tabulators and Report Writing Machines; Custom Data Preparation Devices.
In attendance: Charles F. West, Pres.; Thomas G. Holmes, V. P.; Harlan F. Manweiler, Sec.; James B. Allen, Chf. Engr.

SPENCER MFG. COMPANY, Chicago 41, Ill. **118**
Exhibiting: Automatic control systems; counters.
See ad on page 1760

STANDARD ELECTRONICS COMPANY, Chicago 21, Ill. **322**

STANDARD ELECTRONICS RESEARCH CORP., New York 21, N. Y. **322**
Exhibiting: **New Products**—Serc Integrator. **Regular Products**—Diamatrol—DB Model.
In attendance: Dr. Frederic Fua, Res. Dir.; M. N. Kirby, Sls. Mgr.

HERMAN D. STEEL CO., Philadelphia 6, Penna. **334**
Exhibiting: Swiss Screw Machine Products; Precision Pinions and Gears; Clockwork Mechanisms; Precision Components.
In attendance: William W. Woolford, Manager.

STERLING MANUFACTURING COMPANY, Cleveland, Ohio **408**
Exhibiting: Battery testers; Portable electrical instruments.

STREETER-AMET COMPANY, Chicago 13, Ill. **122, 123**
Exhibiting: Automatic measuring, weighing, and counting machines. Print-out weight and load registers.
See ad on page 1692

STROMBERG-CARLSON CO., SPECIAL PRODUCTS DEPT., Rochester 3, N. Y. **416**
Exhibiting: Precision Limit Detectors.

THE SUPERIOR ELECTRIC COMPANY, Bristol, Conn. **405, 406**
Exhibiting: **New Products**—Tubeless magnetic stabiline automatic Voltage Regulators. **Regular Products**—POWERSTAT Variable Transformers; STABILINE automatic Voltage Regulators.
In attendance: R. J. Caccavelli, A. Stephens, H. Lorenson, Sls. Engrs.; J. S. Louden, Sls. Mgr.
See ad on page 1623

SURPRENANT MFG. CO., Clinton, Mass. **202, 203**
Exhibiting: **New Products**—Teflon jacketed hook-up wire; Extruded Teflon jackets on Teflon insulated wire and Teflon coaxial cables; Silicone rubber hook-up wires; Miniature Coaxial Cables; Low Capacity Coaxial Cables. **Regular Products**—Coaxial cables; extruded Teflon and Kel-F insulated wire; low temperature tubing and jackets; high temperature hook-up wires; wires for miniaturization.
In attendance: G. E. Forsberg, V. P.; D. C. Alexander, Chf. Engr.; D. E. Hollinger, Richard Surprenant, Gerard Mulloney, Edward Olsta, Thomas Kulow, Sls. Engrs.

SWISS JEWEL COMPANY, Phila. 6, Pa. **334**
Exhibiting: Sapphire and ruby jewel bearings, guides, specialties, phonograph points.
In attendance: William W. Woolford, Mgr.

TELEREGISTER CORP., Stamford, Conn. **166, 167**
Exhibiting: **New Products**—Electronic Data Flow Systems for Inventory Control (keyset in booth is tied in to United Air Lines' UNISEL System in Chicago, and current availability information can be read out). **Regular Products**—Automatic Stock and Commodity Quotation Board (live display operated by wire from Teleregister's New York transmitting station); Magnetronic Reservisor; Centronic.
In attendance: W. L. Box, Central Reg. Mgr.; A. F. Goll, Quotation V.P.; John Granbery, D. J. Laughlin, Industrial Sls.; J. H. Mitchell, Industrial Rel. Mgr.; E. L. Schmidt, Industrial V.P.; S. J. Sindeband, Pres.; R. E. Sprague, Fld. Oper. Mgr.; T. M. Steele, Ass't. to Pres.

TELEX, INC., St. Paul, Minn. **210**
Exhibiting: Decade boxes; Slip rings.

TUBE TURNS PLASTICS, INC., Louisville 11, Ky. **417**
Exhibiting: **New Products**—Line of instrumentation Fittings of unplasticized polyvinyl chloride and, for use with them, corrosion resistant Flexible Tubing. **Regular Products**—Injection molded PVC Pipe Fittings.
In attendance: C. B. McLaughlin, Exec. V. P.; Ted Bushnell, Sls. Rep.; Earl Erich, Sls. Engr.

UEHLING INSTRUMENT CORP., Paterson 3, N. J. **418**
Exhibiting: **New Products**—Tel-Flo meter for measuring flowrates and purging line; pressures to 300 lbs. **Regular Products**—Indicators for liquid level, vacuum, pressure; barometers; draft gages; manometers; vacuum and absolute pressure recorders.
See ad on pages 1694, 1780

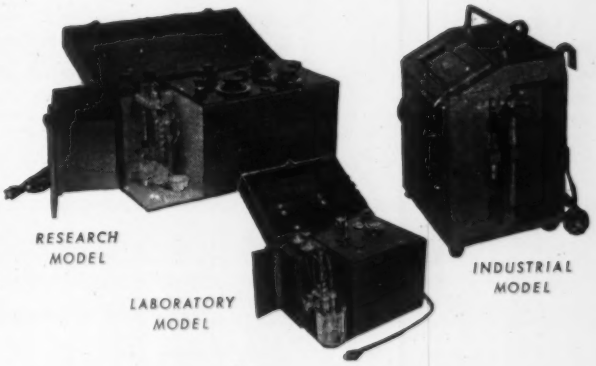
UNITED ELECTRIC CONTROLS CO., Watertown 72, Mass. **164**
Exhibiting: **New Product**—Type E32N indicating temperature control. **Regular Products**—Temperature, pressure and vacuum controls.
In attendance: J. Henderson, W. Sherertz, Sls. Engrs.

VANGUARD INSTRUMENT CORP., Valley Stream, N. Y. **118**
Exhibiting: Process control instruments.

VEEDER-ROOT, INC., Hartford 2, Conn. **411**
Exhibiting: A-c and d-c electrically operated counting devices.
See ad on page 1746

VICTOR ADDING MACHINE COMPANY, Chicago 18, Ill. **218**
Exhibiting: VIC-DAR electronic digital conversion of analog voltage to unitary or binary count, for machine control, listing of information, card or tape punching, mathematical operations, or injection of control information.

WECKESSER COMPANY, Chicago 30, Ill. **330**
Exhibiting: **New Products**—Molded black nylon screws and nuts of hardest grade nylon. Requires no insulating bushings, washers, or sleeves; non-magnetic, non-corrosive, and light in weight. **Regular Products**—NyGrip Cable Clips; EthoLoc Cable Clips; Perforated Plastic Strapping; "D" Washers.
In attendance: Ethan Weckesser, Evelyn Weckesser, Owners; Harry A. Ewalt, Gen. Mgr.; Mary Kay, Sls. Mgr.; Nancy Stirling, Adv. Mgr.; Edward Placzek, Shop Supt.; Alice Schwada; Alice Stemler, Jean Zombek.
See ad on page 1768



Cambridge pH Meters

The three portable models illustrated above incorporate new and important advantages. A.C. line operation eliminates battery nuisance. Laboratory and Research models use electron-ray tube for precise null-point indication. Industrial model is direct-reading, continuous-indicating; ruggedly built for plant use.

Accuracy: Research .02 pH, Laboratory .05 pH, Industrial .10 pH, Cambridge pH equipment also includes single- and multi-point indicators and recorders. Send for Bulletin 910-MR.

CAMBRIDGE INSTRUMENT COMPANY, INC.
3742 GRAND CENTRAL TERMINAL, NEW YORK 17, N. Y.

Pioneer Manufacturers of
PRECISION INSTRUMENTS

For more information circle **65** on inquiry card.

WEST INSTRUMENT CORPORATION, Chicago 41, Ill. **301, 302**
Exhibiting: **New Products**—Tubeless potentiometer Strip Chart Recorder (no vacuum tubes). No gear changing necessary to change chart speed. **Regular Products**—Complete line of temperature controllers, indicators, and accessory equipment. All instruments will be in operation in booth.
In attendance: Richard K. West, Pres.; Ardmore M. Miller, Asst. Sls. Mgr.; William C. West, Jr., Chf. Res. Engr.; Ray Welch, Al Warner, Sls. Engrs.
See ad on page 1691

WESTERN UNION TELEGRAPH COMPANY, Chicago 26, Ill. **459**
Exhibiting: Type 19 Teleprinter (automatic and keyboard sending/receiving); Selector shelf tape-repeater cabinet equipped with one tape Teleprinter; Receiving only page-type teleprinters; Type 14 receiving-only printer-perforator for data processing.
In attendance: R. F. Dirkes, Dir. Facsimile & Private Wire Service; G. A. Trapp, Div. Mgr. private wire services; I. Weiner, C. F. Grout, Div. Sls. Reps. private wire services; Mrs. C. M. Macintyre, Div. Supv. private wire service; Mr. Marie Harrison, private wire services rep.

WOLLENSAK OPTICAL COMPANY, Rochester 21, N. Y. **168**
Exhibiting: **New Products**—High Speed Cine-oscillographic Camera for simultaneous high-speed photography of a mechanical action and its related electrical characteristics. **Regular Products**—Fastax Cameras; Goose control units; Lenses; Timing generators; Lights; Exposure meters; Tripods.
In attendance: Robert D. Shoberg, Mgr. Fastax Div.; William G. Hyzer, Consulting Engr.

ZENITH ELECTRIC COMPANY, Chicago 10, Ill. **306**
Exhibiting: **New Products**—WB Multiple Circuit Timer with individually mounted circuit switches. **Regular Products**—Magnetic Switches; Transfer Panels; Manual Set Timers; Automatic Reset Timers.
In attendance: Lew Coren, Pres.; Norton Ferber, Gen. Mgr.; Victor Helford, Sls. Mgr.; "Casey" Goc, Des. Engr.; John Naudzuinas; John Borris; Robert Eising; Melvin Rukin; Joseph Naudzuinas.
See ad on page 1644

ZOOMAR, INC., Glen Cove, L. I., New York **475**

Maintenance and Servicing of Electrical Instruments
By JAMES SPENCER
Cloth, 278 pages, 274 illustrations. $3.00 postpaid
Payment must accompany order
The Instruments Publishing Co., Inc.
845 Ridge Ave., Pittsburgh 12, Pa.

New Instruments...

INSTRUMENTS and AUTOMATION

Ceramic-and-metal Electron Tubes

SIGNIFICANCE

FRAGILITY, unpredictable life, microphonics and temperature-sensitivity turned many control and servo men from electron tube enthusiasts into seekers of substitutes for tubes during World War II. The following prediction was made in 1947:

"To try to drive them [electron tubes] out of our field would be futile. To drive them out of those automatic-control applications where they DON'T belong is the obvious duty . . . Electron-tube functions, such as rectification, amplification, or oscillation, can be performed by non-electronic devices . . ."*

This was written a year before Bell Labs' announcement of the discovery of the transistor—five years before magnetic amplifiers and transistors became widely available.

A revolution, rather than an evolution, was needed in tube design, construction and manufacture. This is it!

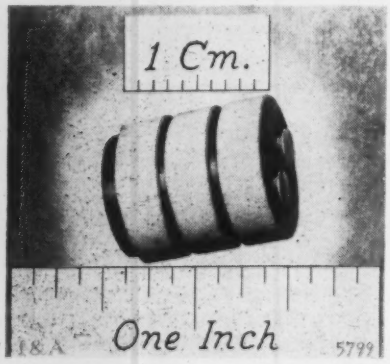
By "this" we mean GE'S announced complete line of ceramic-and-metal tubes for applications including "industrial controls." These coming industrial tubes will, no doubt, possess all of the 6BY4's properties. Of these properties, the most sensational is operability at 500°C, but the most important properties for instrumentation are (1) RIGIDITY, whence minimized microphonics, (2) USE OF TITANIUM, whence rapid cleaning up of gases, (3) CERAMIC BODIES with thermal expansion coefficient virtually equal to titanium's, whence long service life.

Also important will be the purely electrical characteristics of the coming industrial tubes. Some idea of what these will be can be gained from the specifications of the 6BY4:

Electrical characteristics (as Class A amplifier) include plate voltage of 200, amplification factor of 100, transconductance of 6000 micromhos and plate current of 5 ma. Operating results as grounded-grid amplifier when operating at 900 Mc with 10-Mc bandwidth include power gain about 17 db, noise figure about 8½ db and plate current of 5 ma.

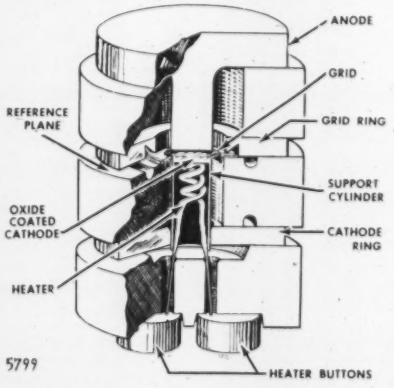
We heartily agree with Dr. C. G. Suits, GE's director of research, that this achievement "shows that the vacuum-tube art is far from dead."—MFB

*M. F. Behar, "Electron Tubes in Instrumentation," *Instruments*, Vol. 20, Nov. 1947, page 1001.



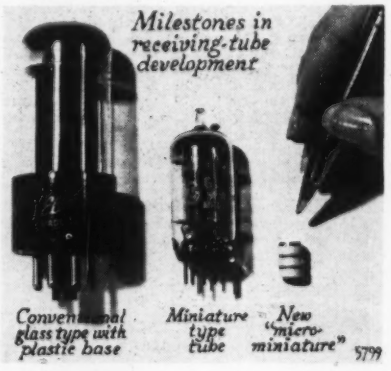
"Microminiature" Triode

New "6BY4" ceramic triode is announced as "designed specifically for UHF TV" but will meet other needs



because it will operate while red hot, resists mechanical shocks and provides extraordinary electrical characteristics owing to micro-spacing of triode elements.—*Tube Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle **301** on inquiry card.



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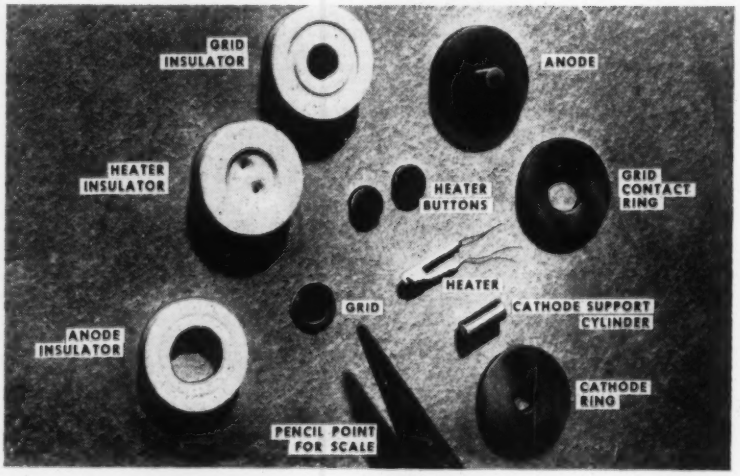
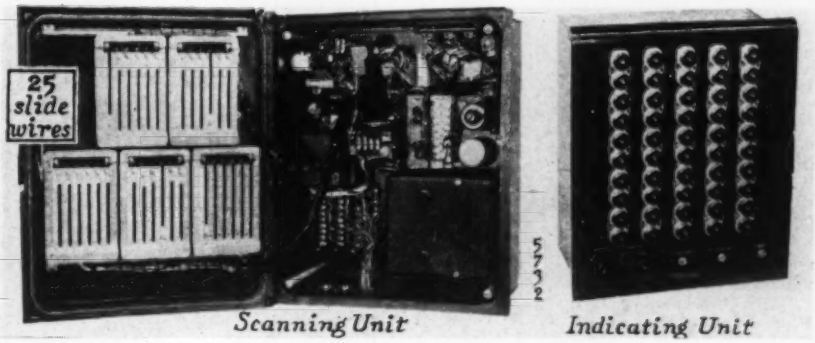
FOR FURTHER INFORMATION use the postage-free order card on page 1781



25-point Monitoring System

New "Electronic Scanner" can monitor up to 25 variables at rate of either 1 or 5 points per second. All 25 points can be set in minutes by untrained personnel on miniature slide wires; and all set points can be viewed and compared at a glance. Built-in "memory" causes scanner to by-pass inoperative points and monitor remainder. Indicating unit has 25 sets of red and green lights; simple two-wire connection to a recorder can give user daily or weekly (or other) charts.—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

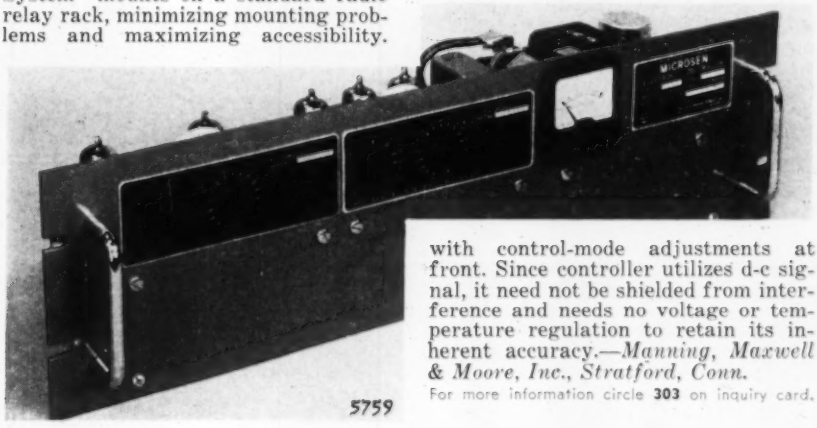
For more information circle **302** on inquiry card.



Scanning Unit *Indicating Unit*

Redesigned Process Controller

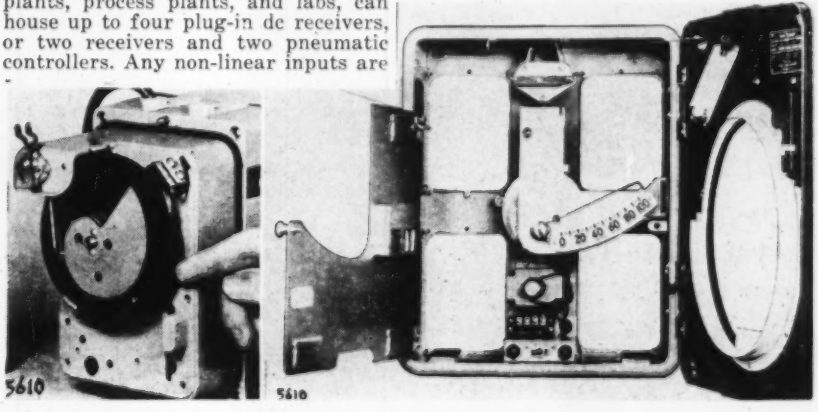
New control unit of "American-Microsen Electronic Process Control System" mounts on a standard radio relay rack, minimizing mounting problems and maximizing accessibility. Control units mounted one above the other form a continuous panel surface with control-mode adjustments at front. Since controller utilizes d-c signal, it need not be shielded from interference and needs no voltage or temperature regulation to retain its inherent accuracy.—*Manning, Maxwell & Moore, Inc., Stratford, Conn.*



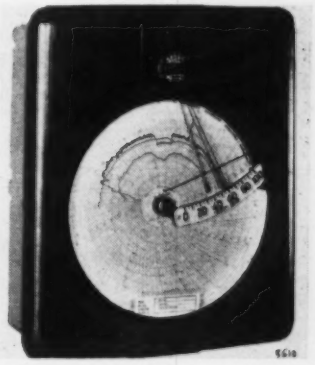
For more information circle **303** on inquiry card.

Self-balancing Receiver-recorder-controller

New "Electronic Receiver Recorder," for dc type pickups and dc telemetering systems used in power plants, process plants, and labs, can house up to four plug-in dc receivers, or two receivers and two pneumatic controllers. Any non-linear inputs are linearized by characteristic cam in receiver. Thus, it is possible to combine four records from dc pickups, ac pick-ups, or pneumatic transmitters, on one uniformly-graduated chart. Each dc receiver operates on potentiometric null-balance principle, using an electronic voltage reference in place of conventional standard cell and battery. Receiver ranges are 0-2 mv to 0-20 v. Sensitivity 0.05%; pen response speed 5 seconds for 0-to-100% of scale.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*

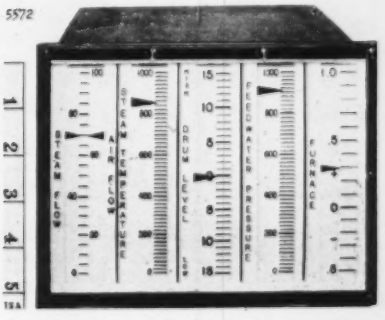


For more information circle **304** on inquiry card.



Receivers and Gages

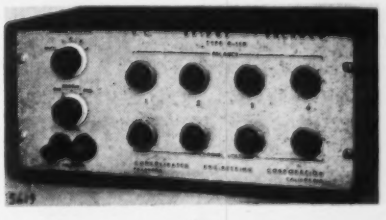
New "V5" small-size receivers and temperature, flow and pressure gages permit compact instrument panels, yet, because of their unique design and illumination, are easy to read even from a distance. Each gage or receiver is an independent unit and can be grouped with as many as eight others in a single case or mounted individually. Units can be used as self-contained measuring instruments or as receivers for pneumatic transmitters and controllers. On most gage models, duplex units are available.—*Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.*



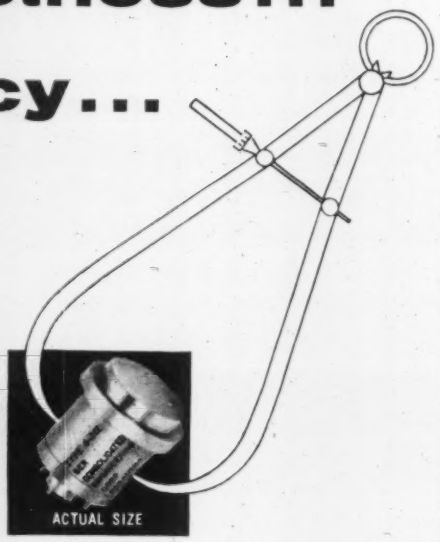
For more information circle **305** on inquiry card.

Bridge Balance

New "Type 8-110" 4-channel bridge balance provides necessary control link between resistive-bridge primary elements and recording or indicating instruments. Up to four 120-ohm to



compactness...
accuracy...



get both with—

CEC PRESSURE PICKUPS

What surprises most engineers the first time they see one of CEC's 4-300 Pressure Pickups is its small size. But when they learn of the performance, surprise often turns to amazement. With the 4-300's, there's no compromise on either compactness or accuracy . . . you get *both* in a single unit, with ruggedness that provides laboratory accuracy under the most adverse conditions of use.

For your next pressure measurement job . . . where you need high accuracy, rapid response and minimum size . . . check these important features, common to all CEC 4-300 Pressure Pickups . . .

WIDE CHOICE OF RANGES . . . gage, absolute and differential units . . . full-scale ratings low as 1 psi, high as 5000 psi.

ACCURACY . . . 0.75% maximum linearity deviation...unusually low hysteresis, temperature effects, and acceleration response.

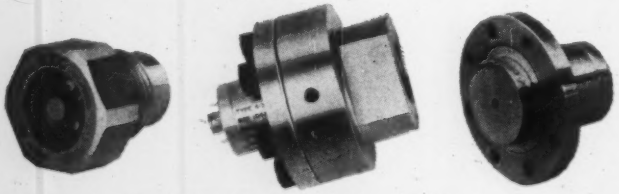
EXTREME MINIATURIZATION . . . bodies as small as ½" in diameter.

STANDARDIZATION . . . same basic sensing element in all models . . . uniform excitation voltage and output greatly simplify system design and operation.

COMPLETE CALIBRATION CERTIFICATE . . . *all* characteristics measured . . . signed certificate sent with each pickup.

ADAPTABILITY...several mounting methods offered . . . standard fittings supplied.

There's a CEC Pressure Pickup for almost every purpose. For complete information let us send you Bulletin CEC 1552-X27



Consolidated Engineering
Corporation

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service Offices Located in: Albuquerque, Atlanta, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

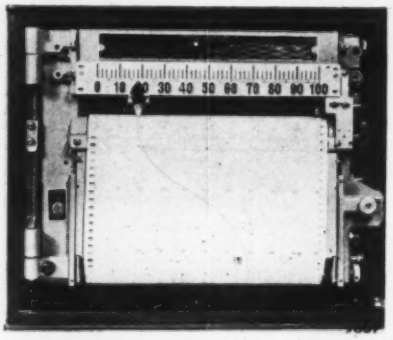
For more information circle **66** on inquiry card.

350-ohm pickups can be connected. Each channel has its own front-panel voltage control, and channel-selector switch connects any desired channel to voltmeter circuit. Pickups of different resistance values can be used simultaneously, and individual sensitivities can be set.—*Consolidated Engineering Corp., Pasadena* 15, *Calif.*

For more information circle **306** on inquiry card.

High-speed D-c Recorder

New high-speed electronic recorder takes 0.25 sec for its pen to cover 11-in chart; is continuously standardized. All components can be replaced to facilitate range changing. Manual

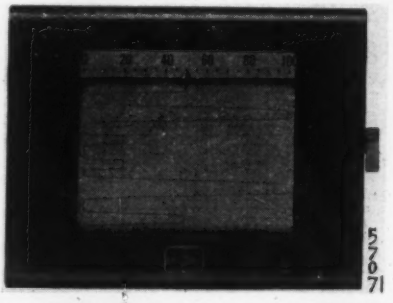


pen lifter prevents ink clogging or tearing of chart paper. Basic chart speeds, 2 ips or 4 ipm; chart-drive step-up mechanism gives 6 iph which can be increased in a ratio of 30 to 1 or 60 to 1.—*Industrial Div., Minneapolis-Honeywell, Philadelphia* 44, *Pa.*

For more information circle **307** on inquiry card.

High-speed D-c Recorder

New "High-Speed Electronic Dynamaster" recording potentiometer features 0.4-sec pen travel across 11-in chart scale without overshoot at end;



has deadband less than 0.1% of full-scale span; is offered with standard ranges as low as 1 mv for full scale, with source resistance up to 10,000 ohms, with chart speeds up to 4 ips. Redesigned pen and pen carriage assure continuous inking at high speeds and prevent damage when pen comes to end of scale. A Thyrite voltage regulator in field circuit of feedback damping generator provides constant damping voltage, regardless of line voltage variation. Damping is adjustable, as is amplifier gain.—*The Bristol Company, Waterbury* 20, *Conn.*

For more information circle **308** on inquiry card.

Gas Density Balance

New Gas Density Balance measures density of a sample gas by a unique null balance principle. A small dumbbell is supported on a horizontal quartz fiber; one ball is punctured and hence has no buoyancy; the other

tends to rise or dip as gas density increases or decreases. Rotational force about quartz fiber is proportional to density of sample gas. Dumbbell is restored to its null position by applying to its surface an electrostatic potential proportional to sample's density. Balancing potential is indicated or recorded. Speed: 95% response in less than a minute; accuracy 0.5% of full scale.—*Arnold O. Beckman, Inc., 1020 Mission St., South Pasadena, Calif.*

For more information circle **309** on inquiry card.

Photoelectric Controller

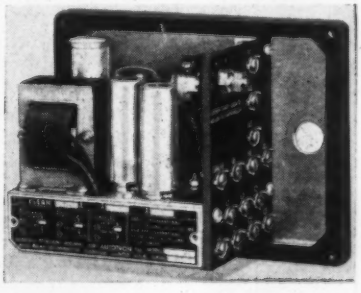
New "Set P4L" ready-to-use photoelectric controller operates over distances up to 100 ft and affords speeds

up to 600 operations per minute. High sensitivity assures positive action under widely varying light conditions and interference caused by vapor or dust. Plug-in chassis provides simple installation and minimal maintenance. —*Photoswitch Div., Electronics Corp. of America, 77 Broadway, Cambridge 42, Mass.*

For more information circle **310** on inquiry card.

Photoelectric Controller

New "Model F1A" is for protection as well as repetitive type applications. Plate relay energizes when light beam

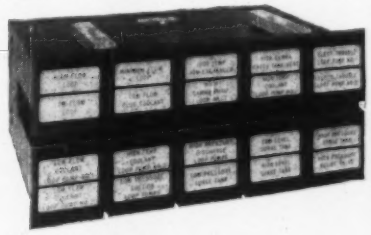


is on phototube and all tubes are operating; relay de-energizes when light beam is interrupted or when a tube filament fails or any tube loses emission, thus affording "fail-safe" operation.—*Autotron Co., Box 722-Q, Danville, Ill.*

For more information circle **311** on inquiry card.

Annunciator Alarm System

New "Model SC-10" annunciators have flexibility and features most commonly required in industrial alarm systems; consist of standard "DE"



line cabinet, special plug-in relays and a special "lite box" with a 2-section backlighted nameplate. Operation of alarm sequence is independent of either of the field signals connected to a common plug-in and "lite-box" combination; is also independent of relay speed, etc. Two important differences from conventional 2-relay-alarm circuit: (1) audible signal cannot be silenced for approximately 8 seconds after alarm first occurs; (2) on recurring alarms, no audible signal without an interval of about 2 minutes between return to normal and realarm of same condition.—*Scam Instrument Co., 3909 W. Irving Park, Chicago 18, Ill.*

For more information circle **312** on inquiry card.

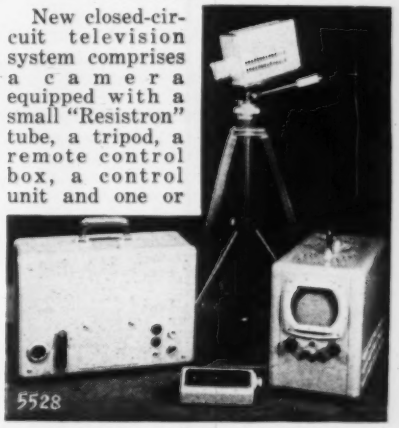
Complete Miniature Line

New miniature electronic indicating-recording and controlling receivers, with transmitters for process variables, supplement maker's miniature pneumatic process-control instrumentation. This is said to be "the first time that a major instrument manufacturer has offered both electronic and pneumatic miniature transmission instruments."—*The Bristol Company, Waterbury 20, Conn.*

No details received as this issue goes to press. Descriptions in our November issue. Meanwhile, circle **313** on inquiry card on page 1781.

Industrial TV

New closed-circuit television system comprises a camera equipped with a small "Resistron" tube, a tripod, a remote control box, a control unit and one or

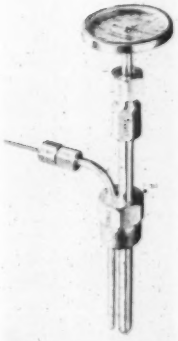


more monitors. "Resistron" tube is relatively insensitive to high temperatures; is small enough for 35-mm camera lenses to be used; has clarity of detail.—*Curtiss-Wright Corp., Wood-Ridge, N. J.*

For more information circle **314** on inquiry card.

TEMPERATURE and HUMIDITY

Check Well



New check well comprises thermocouple and dial thermometer for quick visual check of critical temperature points. Rapid response is attributed to small (3/16 in OD) protection tube and light-gage couple junction bottomed in tube. Both protection tubes are made of 304 stainless steel; process connection and maker's packing glands of 303 stainless. Duplex couples are available in copper-Constantan, Chromel-Alumel and iron-Constantan calibrations. —*Conax Corp., 7811 Sheridan Drive, Buffalo 21, N. Y.*

For more information circle **315** on inquiry card.

Resistance-thermometry Compensated Bulb

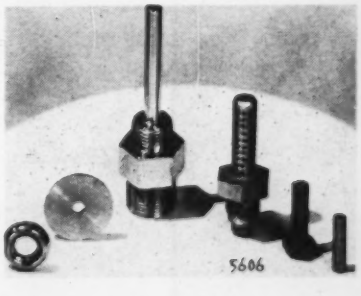
New "Model 242P Resistance Temperature Detector" is said to "measure industrial temperatures to 1300°F with laboratory accuracy"; can be

connected to a remote control panel through ordinary copper wire with no limitation on length of wire (three-lead compensation method); requires no electronic amplification and can be used with inexpensive resistance-bridge electrical instruments.—*Thomas A. Edison, Inc., Instrument Div., West Orange, N. J.*

For more information circle **316** on inquiry card.

Resistance-thermometric High-output Elements

New "High Resistance Temperature Probes" (20,000 ohms) when used with maker's "TME" bridge network,



MISSILE SYSTEMS

Research and Development

Broad interests and exceptional abilities are required of scientists participating in the technology of guided missiles. Physicists and engineers at Lockheed Missile Systems Division are pursuing advanced work in virtually every scientific field.

▪ ▪ ▪

Below: Missile Systems scientists and engineers discuss future scientific exploration on an advanced systems concept with Vice President and General Manager Elwood R. Quesada. From left to right: Dr. Eric Durand, nuclear physicist, systems research laboratory; Ralph H. Miner (standing), staff division engineer; Dr. Montgomery H. Johnson, director, nuclear research laboratory; Elwood R. Quesada; Dr. Louis N. Ridenour (standing), director, program development; Willis M. Hawkins (standing), chief engineer; Dr. Joseph V. Charyk (standing), director, physics and chemistry research laboratory; Dr. Ernst H. Krause, director, research laboratories.

▪ ▪ ▪

Scientific advances are creating new areas of interest for those capable of significant contribution to the technology of guided missiles.

Lockheed **MISSILE SYSTEMS DIVISION**

research and engineering staff

LOCKHEED AIRCRAFT CORPORATION • **VAN NUYS, CALIF.**

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Boston, Mass., Nov. 7-9

The technology of guided missiles is literally a new domain. No field of science today offers greater scope for creative achievement.

Physicists and engineers with special abilities applicable to this field will be interested in new developments at Lockheed Missile Systems Division.

P. E. Alpine and senior members of the technical staff will be available for consultation at the convention hotel, HAncock 6-2044

Lockheed

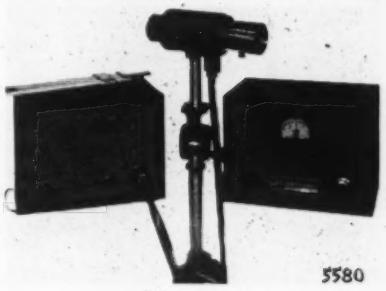
MISSILE SYSTEMS DIVISION

provide 5-volt output signals (without amplification) for as little as 150° temperature change. Units are available for measuring temperatures of fluids, surfaces, structures, hydraulic lines, cylinder heads, etc.—*Arnoux Corp., Dept. IA-4, Box* 34628, *Los Angeles, Calif.*

For more information circle **317** on inquiry card.

Radiation Pyrometer

New "Servotherm IR-2" infrared radiation pyrometer has been engineered for industrial applications;



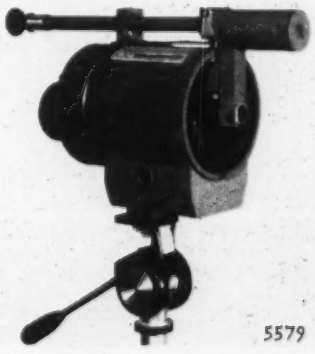
5580

provides remote measurement and automatic control of temperature of moving objects as well as location of hot spots in inaccessible equipment; indicates temperature variations as small as 0.1 F° (smaller when operated by an experienced technician). Range 50°C to 1000°C; response time 250 milliseconds.—*Servo Corp. of America*, 20-20 *Jericho Turnpike, New Hyde Park, L.I., N. Y.*

For more information circle **318** on inquiry card.

Radiation Pyrometer

New "Servotherm IR-1" infrared radiation pyrometer covers nominal temperature range of ambient to



5579

1000°C; is suited for extremely fine measurements; indicates temperature variations as small as 0.1 F° (smaller when operated by an experienced technician). Response time 25 milliseconds. Output can be fed to a recorder.—*Servo Corp. of America*, 20-20 *Jericho Turnpike, New Hyde Park, L.I., N. Y.*

For more information circle **319** on inquiry card.

Temperature Controller

New improved model of "Gardsman" stepless temperature controller, for use with electric furnaces or other electric loads, modulates power input between 3% and 90% so that heat input is only equal to heat losses. No contactors as with conventional off-on systems. Available in ratings from 300 va to 110 kva single- or three-phase (also in higher ratings). Thermal

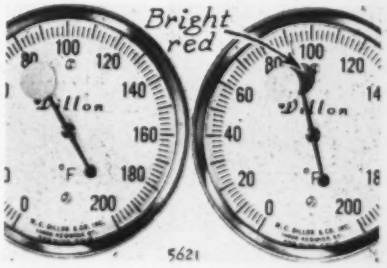
5595

shock to heater elements is eliminated as controller supplies power at a low level once proper temperature is reached. No vacuum tubes are used in this instrument. Multi-load units offer versatility, in that one unit can be used for several different loads and on either 115 or 230 v.—*West Instrument Corp.*, 4355 *W. Montrose Ave., Chicago, Ill.*

For more information circle **320** on inquiry card.

Thermometer Signal

New "Signal Eye" feature tells operator, even from a distance of 50 ft, when normal temperature readings

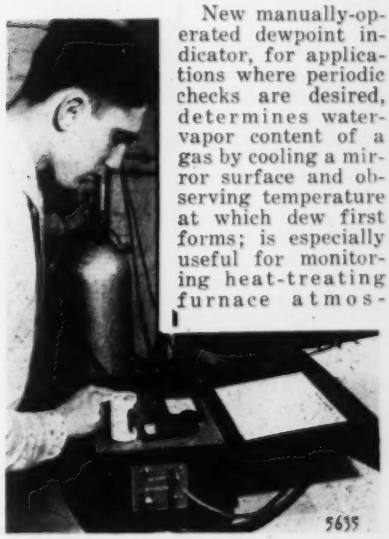


5621

rise or fall. "Signal Eye Thermometers" are available in 3-in or 5-in dial sizes and in stem lengths from 2½ in to 72 in, all individually calibrated to accuracy of 1% scale span, in many F and C ranges.—*W. C. Dillon & Co., Inc., P.O. Box* 3008, *Van Nuys, Calif.*

For more information circle **321** on inquiry card.

Dewpoint Indicator



5635

New manually-operated dewpoint indicator, for applications where periodic checks are desired, determines water-vapor content of a gas by cooling a mirror surface and observing temperature at which dew first forms; is especially useful for monitoring heat-treating furnace atmos-

Circle **67** on inquiry card.

BARBER COLMAN

d-c motors

compact, powerful high quality for a wide range of applications

Looking for a d-c fractional hp motor of unusually high quality, high dependability? Specify Barber-Colman, the *versatile* line of small motors in both permanent magnet and split series types . . . in various mountings and speeds, and outputs up to 1/10 hp. Ideally suited to power electro-mechanical actuators, generators, switches, blowers and programing devices. Barber-Colman small d-c motors are also available with lightweight radio noise filters to meet radio interference requirements of USAF. They are ideally suited for use as tachometer generators. Whatever your problem involving small motors, consult Barber-Colman Company for an expert solution.

Write for free catalog F. 4344-1

BARBER-COLMAN COMPANY

Dept. V, 1415 Rock Street, Rockford, Illinois

For more information circle **68** on inquiry card.

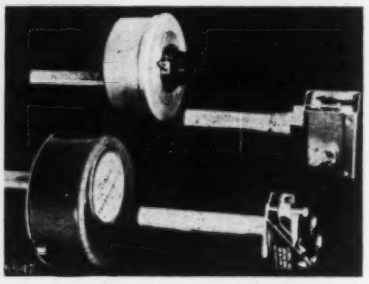
NEW INSTRUMENTS

pheres, also for use by manufacturers and by large users of gases. It indicates dewpoint temperatures from ambient to –100°F (0.0003% moisture by volume in air); operates on a self-contained battery; weighs 16 lbs.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **322** on inquiry card.

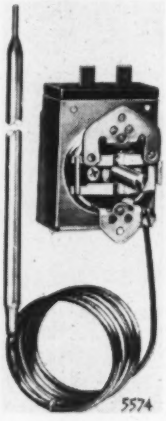
Snap-action Thermostats

New "20,000 Series Thermoswitches" using building-block principle are designed for low-cost temperature control (within 3 F°) or heat retection; come in many combinations of head styles and mounting arrangements for use in gases, liquids or solids in many types of equipment. Starting with basic thermal unit, user can chose among four head styles, two mounting arrangements, six different snap switches, three control ranges, and other operating modifications.—*Fenwal Inc., Ashland, Mass.*



For more information circle **323** on inquiry card.

Appliance Thermostat



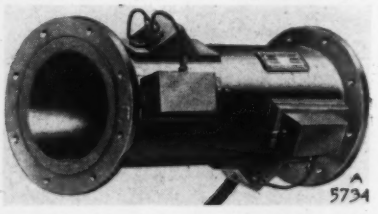
New "EA" low-cost electric thermostat for use in appliances, is suitable also for steam and dry heat tables, glue pots, sterilizers, alarm systems, etc.; is available in direct- or reverse-acting types; features the same snap acting mechanism and thermal unit as in maker's other electric thermostats. Dials (optional) are available in four standard temperature ranges.—*Robertshaw-Fulton Controls Co., Youngwood, Pa.*

For more information circle **324** on inquiry card.

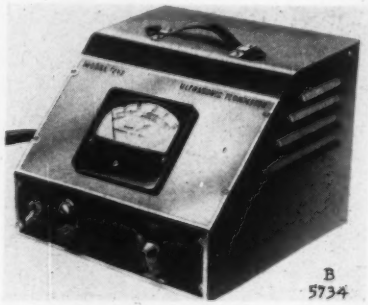
FLOW-RATE and VOLUME

Ultrasonic Flowmeter

New "Ultrasonic Flowmeter," said to be world's first successful industrial ultrasonic flowmeter, measures either mass or volume flow-rate of virtually any fluid regardless of fluid's electrical conductivity, without being affected by accompanying variables and with pressure drop virtually zero (no restriction in pipe section). Principle:



each of two transponders transmits and receives controlled pulses, one diagonally upstream and the other diagonally downstream. Increasing flow-rate increases number of downstream pulses and decreases number of upstream pulses. A unique circuit cancels out sonic velocity by heterodyne technique, leaving only difference in repetition rate (which is proportional to flow velocity). This new method nullifies effect of temperature and density on sonic velocity, so that flow-rate measurement is unaffected by these two variables. Also cancelled out are variations due to pressure, viscosity, gas bubbles, solids in suspension, electrical conductivity or position of installation. Gain control circuit automatically adjusts for variation in sonic attenuation caused by different fluids. A third transducer can be added to volumetric flow-rate meter to give density measurement, converting instrument into a mass flowmeter, whose automatic compensation for variations in density permits the same pipe to be used for different materials with accurate control when switching to a new material. Conventional voltage indicators can be used for either volumetric flow-rate or gravimetric flow-rate output signal. Totalization of mass transferred can be accomplished by integration of gravimetric flow-rate signal, using built-in analog computer.

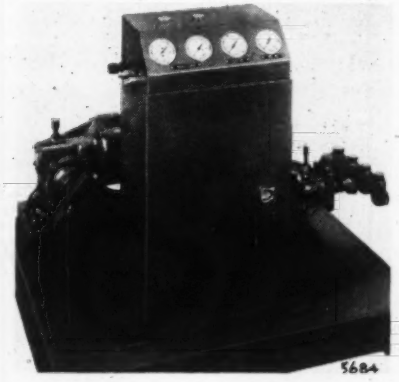


Present design's capacity limit 12,000 lb/min; fluid density range about 2.5 to 1; adaptable to any standard pipe size down to 2 in; temperature limits –50°F and 225°F standard (up to 750°F special); pressure limit 300 psi standard (higher special). Flowmeter's body is made from steel, bronze, aluminum, stainless, or other material, depending upon corrosion-resistance requirements. Rangeability at least 20:1; linearity within 1% of full scale and accuracy better than 2% of full scale.—*Fischer & Porter Co., Hatboro 35, Penna.*

For more information circle **325** on inquiry card.

Flow-control Pump

New controlled-volume pump with instrument-air stroke-length adjustment for use in pneumatic process control systems solves specific low-

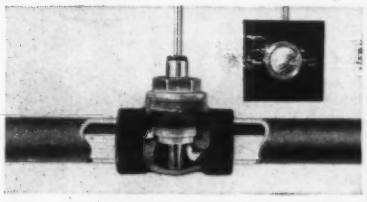


capacity flow control problems; utilizes a unique air servo system with feedback loop to give capacity adjustment with 1% accuracy. Sensitivity: a 1/70 psi change in instrument control air pressure causes resetting of pump stroke length.—*Milton Roy Co., Station N, 1300 E. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **326** on inquiry card.

Flow Switch

New "Model FI-200 Flow Indicator" indicates flow (or lack of flow) of a liquid through a pipe line. Flow through unit actuates a switch that



can operate a pilot light, horn, etc., directly or operate safety interlocks through relays. Models now in production accommodate standard pipe sizes from ¼ in to ¾ in. Normally, any flow over 1.5 gpm causes unit to function. —*Gems Co., 64 Welles Drive, Newington, Conn.*

For more information circle **327** on inquiry card.

Air Velocity Meter

New "Florite" facilitates measurement of throat velocities on ceiling air diffusers. Its "Air Scoop" inlet fits both circular and square diffusers. Range is 0 to 2500 fpm.—*Bacharach Industrial Instrument Co., 7301 Penn Avenue, Pittsburgh 8, Pa.*

For more information circle **328** on inquiry card.

Small-flow Meter

New "Sho-Rate '50' Purge Meter" is said to represent an advanced concept in metering small flows of liquids or gases. It features rugged side-plate construction; is also available with recessed plastic window shield for additional protection. Tubes are easily removed for cleaning or replacement without disassembling meter. End fittings quarter-turn positioning facilitates piping and mounting. Available in wide-range "Dual-Taper Model" with two scales etched in different colors on metering tube against a yellow background. Also available with constant differential relay.—*Brooks Rotameter Co., Lansdale, Pa.*

For more information circle **329** on inquiry card.

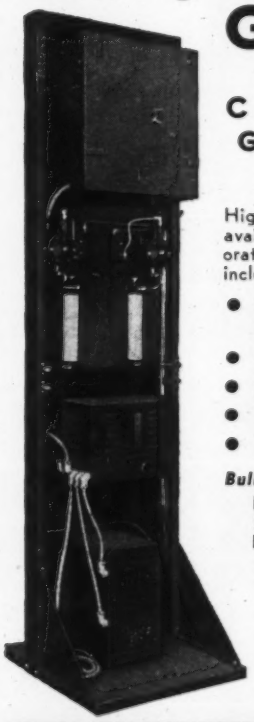
Batching Meter

New 1½-in and 2-in "Auto-Stop" meters feature double-trip "Auto-Stop" valves for automatic deliveries of water, syrups, oils, solvents and other liquids to batching and blending processes with accurate cut-off and minimal hydraulic hammer even when handling high rates of flow. When applied to low viscosity liquids such as water, "Auto-Stop" valve is fur-

For Recording, Indicating, and Controlling

GOW-MAC

THERMAL CONDUCTIVITY GAS ANALYSIS APPARATUS



High accuracy, low cost instruments available for plant streams and laboratories. Recommended applications include—

- **GAS CHROMATOGRAPHY**
- **GAS MIXING**
- **GAS PURITY**
- **PROCESS CONTROL**
- **TRACE IMPURITY**

Bulletins available on

PANEL INSTRUMENTS
SENSING ELEMENTS
PORTABLE INSTRUMENTS

Complete information on Gow-Mac Gas Analysis Apparatus, including illustrated bulletins, is available on request. Please mention the type of apparatus in which you are interested. Inquiries should be addressed to Dept. I.

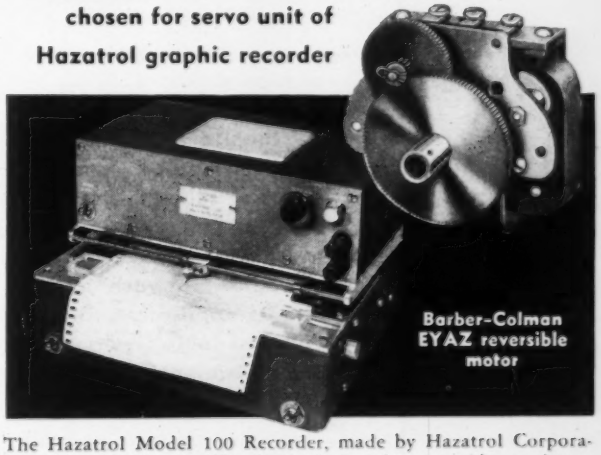
GOW-MAC INSTRUMENT CO.
100 KINGS ROAD, MADISON, N. J.

For more information circle **69** on inquiry card.

BARBER COLMAN

Small Motors

chosen for servo unit of Hazatrol graphic recorder



The Hazatrol Model 100 Recorder, made by Hazatrol Corporation of Palo Alto, California, is designed to provide maximum versatility for a wide variety of product testing and research applications. The chart pen is positioned by a self-balancing potentiometer type servo employing a Barber-Colman EYAZ reversible motor. For highly dependable actuation of your instruments or products, too, there is a wide selection of Barber-Colman small motors up to 1/20 hp. Unidirectional, synchronous, and reversible . . . with or without gearing . . . open or enclosed. Write for data sheets.

Barber-Colman Company

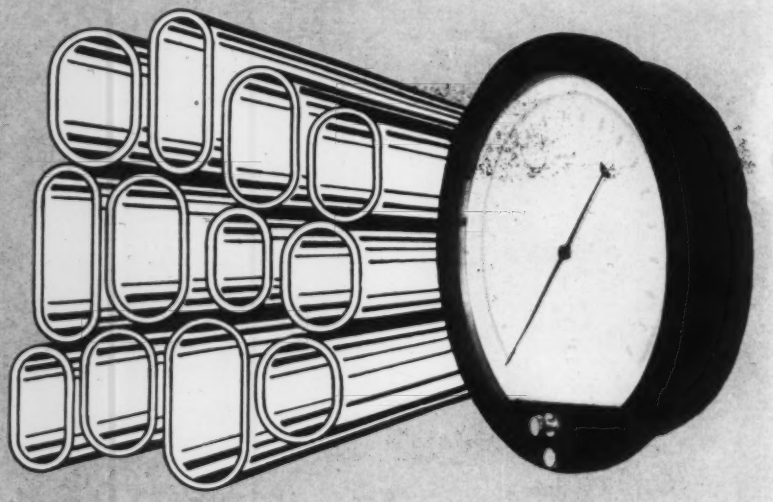
Dept. V, 1215 Rock St., Rockford, Ill.

For more information circle **70** on inquiry card.

HEISE GAUGES

Designed for Dependability

Does your high pressure gauge application require a scientifically designed Bourdon Tube?



Where highly accurate results are required design considerations such as the depth — width ratio of the Bourdon Tube section are of paramount importance.

Extreme fiber stress resulting from improper design of the tube may render an apparently good instrument completely undependable.

At the Heise Laboratories, mathematical solutions for determining the size and shape of Bourdon Tubes for specific use are augmented by years of research and tests on various types of tubes to assure correct stress distribution.

Heise Bourdon Tubes are heat treated by scientific methods to guarantee that each tube will be metallurgically sound for its application. The precision heat treatment of thin walled tubing without distortion has been made possible by equipment and technique developed by Heise Laboratories.

Catalog on Request

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"—12"—16"

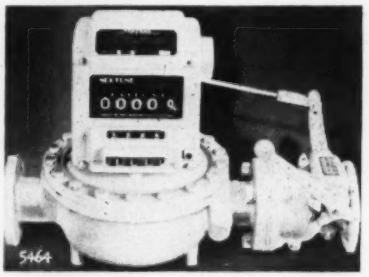
Prices from $151.60. **DELIVERY WITHIN 30 DAYS.**

HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **71** on inquiry card.

NEW INSTRUMENTS



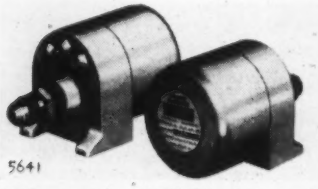
nished with a double-trip or cushioned-stop mechanism which slows down fast-moving stream an instant before it shuts off flow. ★Also available is maker's "Auto-Switch" (explosion-proof) for control of pumps, agitators, valves, etc., when desired quantity of liquid has passed through meter.—*Neptune Meter Co., 19 West 50th St., New York 20, N. Y.*

For more information circle **330** on inquiry card.

PRESSURE

High-Vibration Pressure Pickup

New "Model 45154S" is a new "high vibration" version of maker's "45154 Series"; meets all performance requirements while subject to a sinoidal vibration of 25 *G* at frequencies up

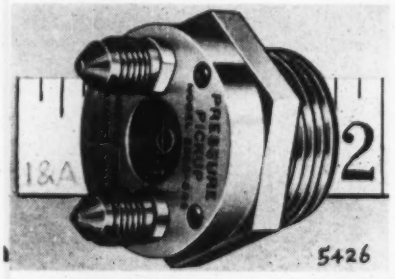


to 2000 cps; is available in pressure ranges up to 0-20 psia, psig or psid. Repeatability is within limits set by resolution of 230-wire resistor winding (0.45%).—*G. M. Giannini & Co., 918 E. Green St., Pasadena 1, Calif.*

For more information circle **331** on inquiry card.

High-temperature Pressure Pickup

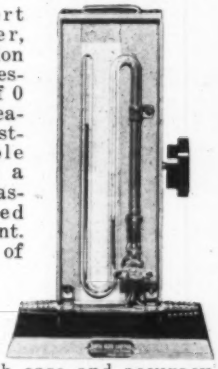
New "Model 2502," for rockets and engines, as well as chemical and processing industries, operates under tem-



peratures as high as 2200° F; features cooling-passage design, flat frequency response from 2 cps to 5000 cps, and large output (40 mv/psi) in 0-500-psi range (other available ranges 1000, 2500, and 5000 psi).—*Dept. I&A, Endevco Corp., 180 E. California St., Pasadena 1, Calif.*

For more information circle **332** on inquiry card.

Absolute-pressure Gage



New Bennert type manometer, for determination of absolute pressures in range of 0 to 240 mm, features zero adjustment of movable scale through a rack-and-pinion assembly enclosed within instrument. Knob on side of aluminum housing permits operator sliding scale to manipulate sliding scale with ease and accuracy, glass parts can be obtained separately and installed by user in event of breakage.—*Kontes Glass Co., Vineland, N. J.*

For more information circle **333** on inquiry card.

Pressure Gages

Two new series of gages for process industries are manufactured to grade AA Test Gage accuracy. "Supergauges" are available in cast case construction; "Solfrunts" have a solid front with safety blow-out back to protect workers. Nylon-faced stainless steel segment and stainless steel pinion are said to give extended life under severe operating conditions. Other features common to both lines include "mono-unit" construction for easy removal of entire gage assembly from case for inspection. "Arc-Loc" construction for rapid adjustment (not necessary to remove dial in order to adjust). Available in 4½-in, 6-in and 8½-in sizes in back flange, front flange, and turret type cases.—*U. S. Gauge, Sellersville, Pa.*

For more information circle **334** on inquiry card.

Test Gages

New "Laboratory Test Gauges," available in 4½ in, 6 in and 8½ in. sizes, are manufactured to grade AA Test Gage accuracy. Ranges from 15 to 20,000 psi make these gages suitable for replacing or augmenting dead-weight testers or manometers.—*U. S. Gauge, Sellersville, Pa.*

For more information circle **335** on inquiry card.

Pressure Switches

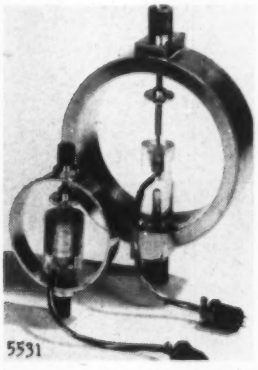
New "Series 6300" miniaturized (2-in long) vibration-resistant differential-pressure and gage-pressure switches for aircraft and missile systems applications weigh about ⅓ lb; are designed to withstand vibration up to 35 *G*; are sealed against moisture, dust or explosive atmosphere; are available with Cannon plug or with lead wire connections. Operating temperatures from –65°F to 165°F; operating pressures from 2 to 50 psi.—*Southwestern Industries, 5880 Centinela Ave., Los Angeles 45, Calif.*

For more information circle **336** on inquiry card.

FORCE, LOAD and ACCELERATION

Force and Weight Pickups

New models have been added to "Series 140 Load Transducers" so that available full-scale ranges now run

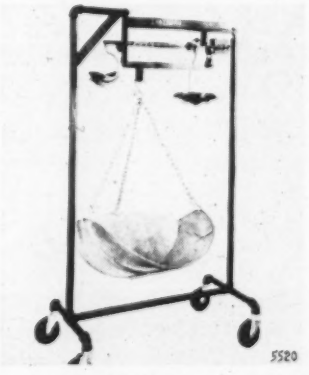


from 5 to 100,000 lbs. Each unit combines a differential transformer and a proving ring. Mechanical hysteresis less than 0.1%; temperature effect 0.025% per F degree; linearity 1%.—*Daytronic Corp., 216 South Main St., Dayton 2, Ohio.*

For more information circle **337** on inquiry card.

Portable Counting Scale

New "Model No. 1208" has been especially designed to fit between narrow stock bin aisles: is 32 in wide, 38



in long, and 64 in high. Capacity 150 lbs (larger capacities if desired). Ratios 9:1 and 99:1 (10:1 and 100:1 if preferred).—*John Chatillon & Sons, 85-93 Cliff St., New York 38, N. Y.*

For more information circle **338** on inquiry card.

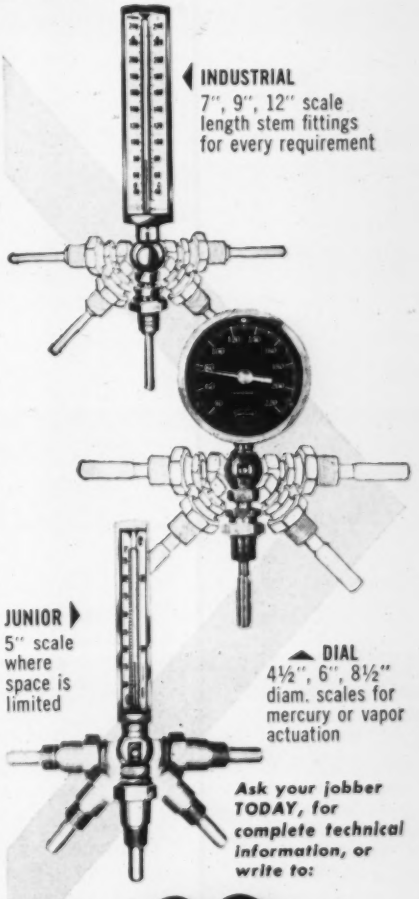
Remote Digital Totalizer for Dial Scales

New totalizer that digitizes weight readings can be used with any industrial dial scale; is especially useful in processing (and receiving or shipping) material through an automatic hopper scale connected to a dial scale. In a batching operation involving mixing of several ingredients, the various

ADJUST-ANGLE THERMOMETERS

for any application ...for any industry!

Weksler ADJUST-ANGLE thermometers position to any angle through 180° arc, either before or after installation, by a simple locknut adjustment. Solves intricate installation problems with greater visibility at odd angles. Tested to withstand shock, vibration and strain, even under the most rugged conditions. Reduces installation and maintenance worries.



Ask your jobber TODAY, for complete technical information, or write to:

WEKSLER INSTRUMENTS

WEKSLER THERMOMETER CORP.

Dept. AA • 195 East Merrick Road

Freeport, L. I., N. Y.

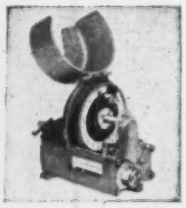
For more information circle **72** on inquiry card.

CIRCUIT CONTROLLING COUNTERS *with* Automatic Reset

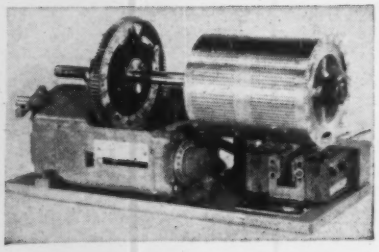
FOR REVOLUTION, STROKE AND ELECTRIC COUNTING

THESE predetermining counters with instantaneous reset will automatically recycle a variety of single and multi-stage switch functions. Recycling operates without time lag at speeds to 5,000 rpm. The switching pattern repeats automatically as long as desired. The control circuit is an integral part of the equipment.

CYCLO-MONITORS



Used to control one or two switching events within a preset count-cycle. Replace unwieldy change gears, cam systems, timing chains, etc.—provide quick and completely flexible adjustment for changing requirements. Adjustment in one-count increments extends over a wide range of numbers. Available in a variety of models—*write for General Catalog of Cyclo-Monitors.*



PROGRAMONITORS

Same cycle range as Cyclo-Monitors, but also permit ANY NUMBER of intermediate switching events. Complex switching patterns of any countable sequence can be programmed and automatically repeated. Momentary or dwell switching—continuous or intermittent operation. Built-in control circuit can be opened or closed at any numbers. ***Write for Bulletin 505.***

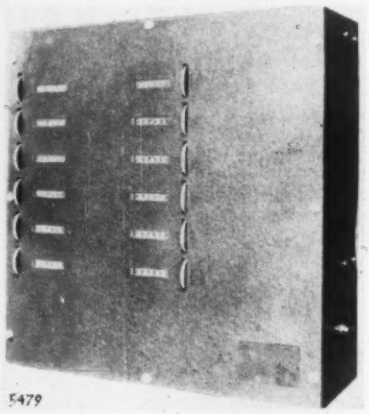
COUNTER AND CONTROL CORPORATION

5230 W. Electric Ave.

MILWAUKEE 14, WIS.

For more information circle **73** on inquiry card.

NEW INSTRUMENTS



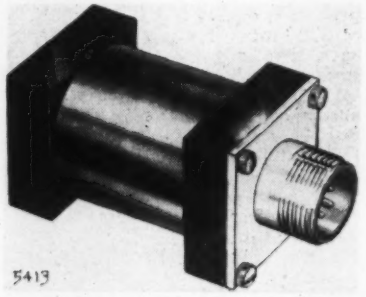
5479

amounts of materials present in mixer at any time can be immediately read off the different totalizers, all of which are six-digit.—*Richardson Scale Co., Clifton, N. J.*

For more information circle **339** on inquiry card.

Acceleration Pickups

New diversified series of acceleration pickups offers a wide selection of single and multi-axis devices (only



5413

one shown) that have been fully qualified for aircraft applications and are suitable for industrial applications. Wide choice of ranges, damping ratios and output resistances or impedances. Temperature-compensated damping available.—*Cedar Engineering*, 5806 *W. 36th St., Minneapolis* 16, *Minn.*

For more information circle **340** on inquiry card.

TIME, SPEED and COUNTING

Visual Tachometer

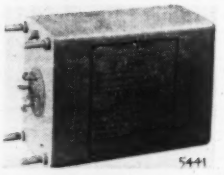
New "Visutac" measures rotary or vibratory speeds from a distance (of 3 ft to infinity). Its spring-wound mechanism stops motion by strobo-

5515

scopic principle (interrupted line-of-sight type). It is made in two basic ranges: 500-8,000 and 1,000-16,000 rpm-vpm. It is accurate to 2% at any scale point above first 15% of either scale. It is as self-contained as a watch; can be wound, focused, synchronized to stop motion and read at leisure.—*Boulin Instrument Corp.*, 65 *Madison Ave., New York, N. Y.*

For more information circle **341** on inquiry card.

Proportional-delayed-reset Time Delay Relays



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New time delay relays provide a proportional delayed reset after current interruption; can be supplied hermetically-sealed in extruded aluminum housing (shown) or in a standard dust cover. Available time delays from 5 sec to 1 hr and reset times from 30 sec to 7½ min. Standard or governed dc, or 60 or 400-cps ac motors can be provided on these units.—*The A. W. Haydon Co., Waterbury, Conn.*

For more information circle **342** on inquiry card.

Industrial Timer

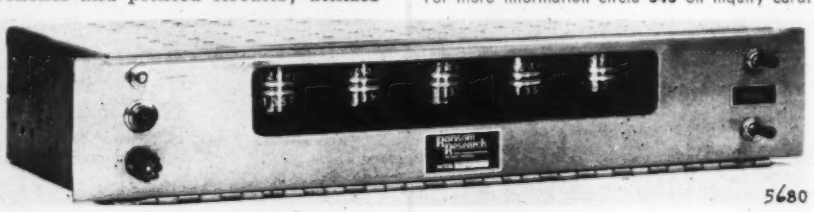
New "Model 2 Type CK" cold-cathode-tube electronic timer has a built-in voltage regulator to nullify effect of line-voltage variations so that timed interval varies less than 2% of full-scale for any line-voltage change between 95 and 125 v. Available in front-of panel-mounting (shown) and back-

Electronic Counter

New "Type 200 Series" high-speed digital electronic counter is capable of 250,000 counts per second; features modular design of basic plug-in components and printed circuits; utilizes

"Type 105 Series" plug-in decade scalers which employ a direct-reading counting tube.—*Ransom Research, P. O. Box* 382, *San Pedro, Calif.*

For more information circle **343** on inquiry card.



5680

SECOND INTERNATIONAL

AUTOMATION

EXPOSITION

CHICAGO NAVY PIER—NOV. 14-17, 1955—OPEN FROM 2 to 10 PM

ON DISPLAY

The most advanced devices for control of plant and office operations—all under one roof.

Automation's prime movers—the individual elements of the "automatic factory" will be assembled and presented in a space small enough to permit perspective of the entire field

. . . and large enough to contain ALL of the important elements.

FREE bus service from downtown hotels to the Pier.

FREE admission to the exposition.

Registration fee for each clinic is $5.00 →

TWO CLINICS

1. A Conveyor Automation Clinic, under direction of A. T. Gaudreau, Management Consultant, will be presented by individual conveyor exhibitors to cover these subjects:

Work-positioning at the machines Inter-machine material transfer Inter-flow material handling Inter-building material transport Automatic handling: assembly to storage

2. Electronic Computer Clinic. Never before has this new and dramatic field been presented with the express purpose of comparing ALL of its aspects.

Manufacturers of all basic computer types will have exhibits planned to answer specific questions. Clinic sessions (2-hour classes) will be offered by the computer manufacturers.

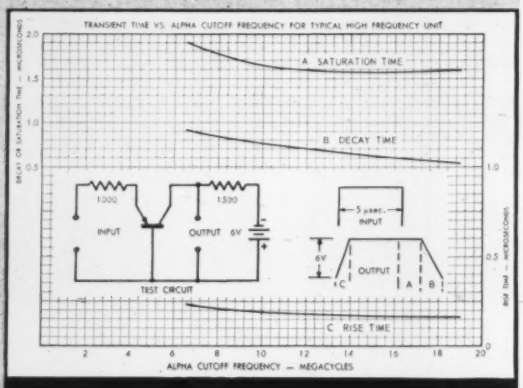
REGISTRATION FOR BOTH CLINICS is limited. Write or phone the Clinics' Director, 2nd International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.—FAirfax 1-9831.

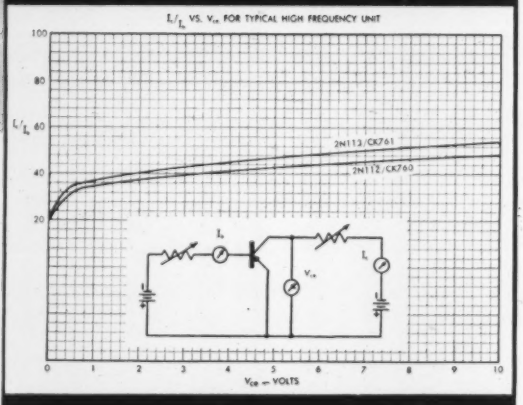
New Information OF INTEREST TO Computer Engineers and Designers

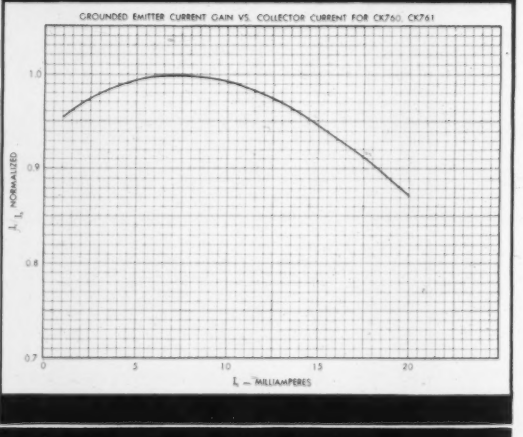
on the NEW

RAYTHEON

RF Transistors







RAYTHEON RF TRANSISTORS ARE

- *completely interchangeable* without selection of components
- *successfully field tested for an entire year.* In mass production for several months.
- made by the Raytheon perfected *fusion* process that has already produced nearly *two million* transistors

HIGH FREQUENCY TRANSISTORS — HERMETICALLY SEALED CASE

Type	Collector		Emitter		Extrin. Base Resis. ohms	Base Current Ampl. Factor	Alpha Freq. Cutoff mc.	Max. Junc. Temp. °C	Temp. Rise °C/mW	Coll. Capac. μμf
	Volts	Cutoff μA	mA	Cutoff* μA						
2N112/CK760	−6	1	−1.0	0.5	75	40	5	85	0.62	14
2N113/CK761	−6	1	−1.0	0.5	75	45	10	85	0.62	14

*Cutoff current measured at Vc = −12 volts Note: above characteristics are average except where noted

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass., Bigelow 4-7500

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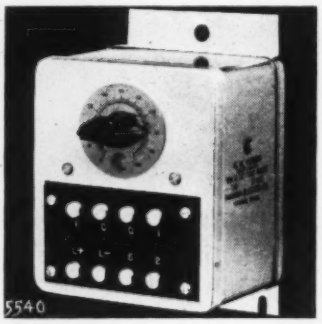
RELIABLE SUBMINIATURE AND MINIATURE TUBES - SEMICONDUCTOR DIODES AND TRANSISTORS - NUCLEONIC TUBES - MICROWAVE TUBES - RECEIVING AND PICTURE TUBES

For more information circle **74** on inquiry card.

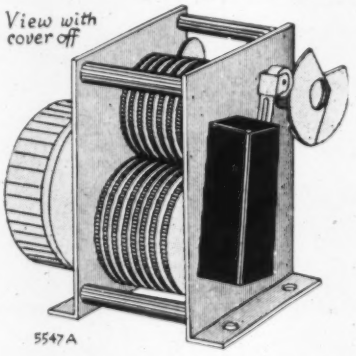


of-panel mounting; also in six operating modes including self-recycling; also in eight full-scale ranges from 1/5 sec to 60 sec.—*Farmer Electric Products Co., Inc., 21 Mossfield Road, Waban, Mass.*

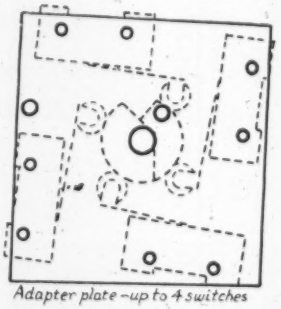
For more information circle **344** on inquiry card.

Program Controller

New "MG Timer and Program Control Instrument" features ten instantly-selected speeds to move cam or pro-



gram disc in one revolution per minute (lowest speed) to one revolution per four weeks. Cam as shown or 6-in pro-



gram disc to handle 10 switches. Adjustable cam gives from 5% to 95% of time cycle ON or OFF. Other models available with 13 speeds, also motors with 40 oz-in torque on programming applications up to 25 switches.—*Gorrell & Gorrell, Haworth, N. J.*

For more information circle **345** on inquiry card.

Preset Counters

New "Ti" series of "Sodeco" electric impulse counters featuring preselection are available with manual push-button reset or electric reset; are fast (up to 12 impulses per second) and can be preset to any number up to 99999 by pressing pins (near top of front plate) and simultaneously

turning wheel at left. Pins can then be sealed to prevent tampering. As impulses come in, upper (preset) register subtracts and lower (counting) one adds. If desired, counter will automatically reset to original preselected figure at end of each counting cycle. Secondary contact can serve for automatic batching.—*Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.*

For more information circle **346** on inquiry card.

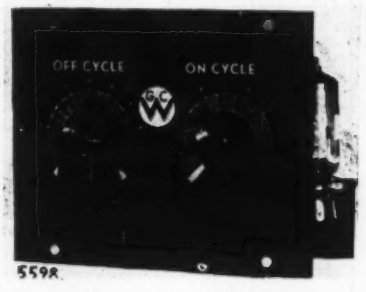
Electric Counter

New "Type E-RSA-200" five-digit electric counter is designed for reliable high-speed impulse registering. (Final-inspection tests, 20 impulses per second.) It is suitable for installation in small spaces, measuring ¾ x 1-3/16 x 4-1/16 in over-all; enclosed in metal cover but available as individual units or in strips of ten with a common cover. Mechanism is built so that wheels cannot jam or get out of mesh. Counter wheels are made of nylon for long wear. Coil is terminated with soldering lugs in rear.—*North Electric Company, Galion, Ohio.*

For more information circle **347** on inquiry card.

Repeat Cycle Timer

New "Model No. 4" is a low-cost electronic repeat cycle timer, suitable for design into automatic machines or



for process control. It utilizes two cold-cathode triodes: no warm-up and no filament power. Independent adjustability of both On and Off Cycles from 0.1 to 12 seconds is provided. Output is sp-dt relay with 5 amp contacts.—*G. C. Wilson & Co., 1915 Eighth Ave., Huntington, W. Va.*

For more information circle **348** on inquiry card.

Glow Counting Tube

New "GS 12 D" model of "Dekatron" is a 12 cathode tube, has a 13-pin base, plus two extra flying leads. Plug-in base design is expected to open up new applications "previously impossible with other tube models,"

FLIGHT INSTRUMENTATION
by RAHM

potentiometer type transducers for use at temperatures between −60° C. and +120° C.

Designs available for operation to 160° C.

- PRESSURE
- ALTITUDE
- AIRSPEED

Designs available permit single or multiple range linear output from non-linear input function, and operation over wide ranges of environmental conditions.

- ACCELERATION
- PRESSURE SWITCHING
- ALTITUDE CONTROL

Request Catalog #954

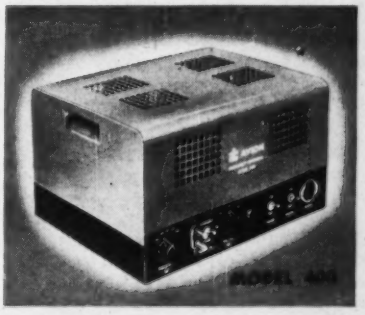
RAHM INSTRUMENTS, INC.
12 WEST BROADWAY, NEW YORK 7, N. Y.

For more information circle **75** on inquiry card.

THE NEW FREQUENCY CONVERTER
by AVION

A 400-CYCLE POWER SUPPLY
BENCH SIZE

- PLUGS INTO 60-CYCLE LINE
- DELIVERS 100 VOLT-AMPERES
- OUTPUT FREQUENCY ADJUSTABLE
  380-420 cps—Panel Control
  200-1700 cps—External Control
- OUTPUT VOLTAGE ADJUSTABLE
  90-130 volts—Panel Control



Frequency Regulation: Better than ± 1 cps
Voltage Regulation: Better than ± 1%
Harmonic Distortion: Total better than 3%
} Independent of power factor and 10% line variation

The small size (17" long x 9" high x 13" deep), power output (100 V-A), and low cost afford the convenience of using one converter for each bench set-up. Four hundred cycle power handling capacity need be paid for only as required.

Send for complete data on this new Avion product

OTHER AVION PRODUCTS
Electronic Choppers • Voltage Regulators & References • Altitude & Air Speed Control Units
Magnetic Memory Systems • Miniature Plug-In Amplifier Units • Multron
Power Supplies • Replaceable Subminiature Amplifier Assemblies • Signal Generators

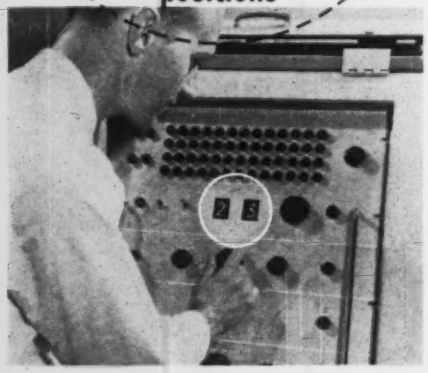
AVION
INSTRUMENT CORP.
Division of A C F Industries, Incorporated
299 Highway No. 17 • Paramus, New Jersey

For more information circle **76** on inquiry card.

Northrup Engineers use

E-I DIGITAL IN-LINE READ-OUTS

to visually display computer test positions



Small, compact decades save space; provide digital accuracy at a glance

The test console shown above is used by Northrup engineers to test missile-borne computer resistance values on a "go, no go" basis. Electrical positioning of the "go, no go" switching is displayed on two E-I Digital In-line Read-outs, to aid in locating any "no go" values which appear during the automatic cycling of the tester.

Two E-I decades, mounted in the center of the console, enable 99 positions to be displayed. Old style techniques would have required 99 pilot lights or 99 front panel switches. Important too, use of E-I In-line Read-outs assures unambiguous readings. Since test positions are displayed digitally, no interpretation is required, minimizing chance of reading error.

Adaptable to a Variety of Uses!

NO MOVING PARTS—Numbers engraved on lucite plates, arranged in depth. Only number or symbol which is edge-lighted appears in window.

GOOD READABILITY—Special techniques minimize incident lighting effects. 1-inch numerals are easily read at 30 feet.

FAST RESPONSE—Limited only by bulb response.

SMALL IN SIZE—1-inch and ½-inch models available.

NO MAINTENANCE—Other than occasional bulb replacement.

EASILY MOUNTED—Tapped holes provided for panel mounting.

1-, 2-, 3-, 4- & 5-decade models available. Write for complete information.

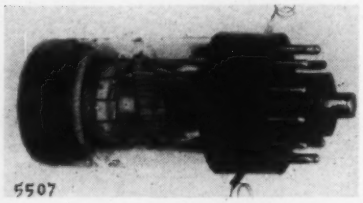
ELECTRO INSTRUMENTS INCORPORATED

3794 Rosecrans Street, San Diego 10, Calif.

Engineering representatives throughout the United States and Canada

For more information circle **77** on inquiry card.

NEW INSTRUMENTS

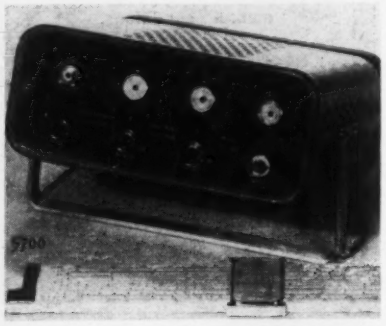


according to maker. Counting scale of 12 adds to value of new tube in studies involving dozens, gross, inches, etc., and makes new tube a useful divider in many types of timing units. Counting rate 0-4000 pps. Maximum total anode current 0.35 ma; maximum voltage between electrodes (other than anode) 140 v; minimum supply voltage (anode to cathode) 350 v.—*Atomic Instrument Co., 84 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **349** on inquiry card.

Electronic Counter

New "Model WE-160" is a portable (6 lb incl. power supply) four-decade electronic counter featuring small size

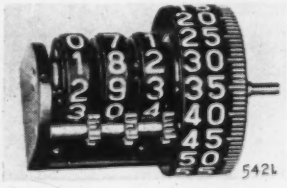


(3 models can be mounted side by side in a 3½ x 19 in panel), combination of glow transfer tubes and simplified circuitry. With 60-cps power frequency as time base, it can be used to calibrate timers, relays, actuators, etc. High counting rate makes it an excellent radiation counter.—*Westport Electric, 149 Lomita St., El Segundo, Calif.*

For more information circle **350** on inquiry card.

Counter for Navigating Instruments, etc.

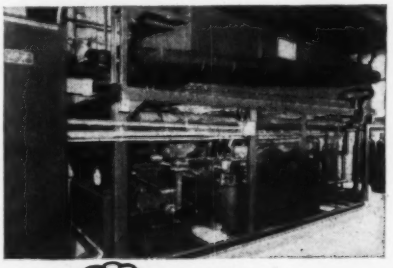
New "Model 4-H-8455" counter assembly consists of three number wheels and a drum-type wheel con-



taining figures and 100 graduation lines. For day and night reading, numbers and graduation lines are white-green fluorescent. Speed 500 rpm or 50,000 counts per minute.—*Durant Mfg. Co., 1914 No. Buffum St., Milwaukee 1, Wis.*

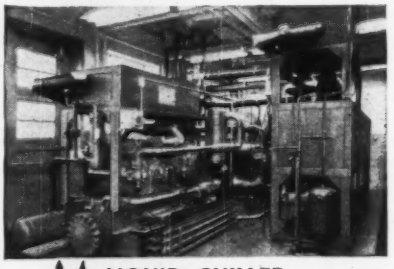
For more information circle **351** on inquiry card.

AR conditions AIR & LIQUID for TEST FACILITIES



AIR CHILLER

Provides 4 to 50 lbs. or more of air per minute at −70° F or lower continuously without dryers at pressures to 15 psi or higher. Elevated temperatures also available. Rapid raising and lowering of temperature can be provided as well as vacuum pump equipment for simulating cold air at high altitudes. Complete unit custom designed with automatic defrost.



LIQUID CHILLER

Conditions any liquid — fuel, corrosive or non-corrosive — at pressures to 1000 psi and higher with flows of 100,000 lbs. per hour if required. Temperatures of −70° F or lower or elevated temperatures if required.

Other American Research test facilities include simulation of **Altitude, Temperature** and **Humidity** in any combination, **Sand and Dust, Explosion, Rain and Sunshine** and **Fungus,** as well as **Industrial Processing Equipment** and a new line of **Hydraulic Test Stands.**

Write for complete catalog.

AMERICAN RESEARCH CORPORATION

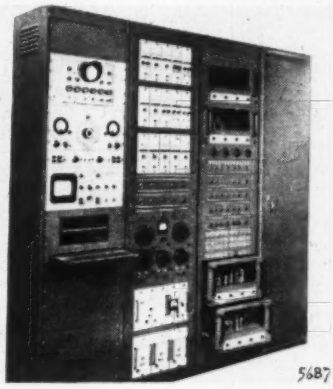
383 BROOK ST. BRISTOL, CONN.

For more information circle **78** on inquiry card.

COMPUTING and DATA HANDLING

Computer Components

New "Servomation Building Blocks" electromechanical general-purpose analog computer components, in numerous possible combinations, provide means for industrial production con-



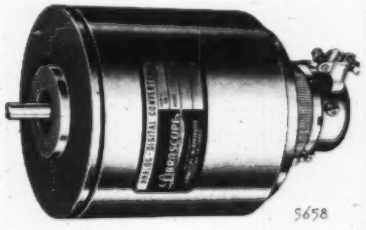
5687

trol, problem solving for both equations and control system design, classroom demonstration and experiment and data processing. They match one other in all important mechanical and electronic specifications. Flexibility is achieved by plug-in units, internally-wired cabinets, jack boards and external patch cord connections. Units can be rearranged and additional components added with ease at any time. —*Servo Corp. of America*, 20-20 *Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **352** on inquiry card.

Analog-to-Digital Converter

New "Binary Coded Decimal Converter," for data recording systems, control panels, automatic coordinate



5658

plotting, and producing signals for automatic control systems, can be used also to control punching of IBM cards, paper tape or printer. It will function dependably in a shock environment to 20 *G*; is non-sensitive to magnetism; is operable at temperatures from –50° to 85°C; is available in single-, double- and triple-disc models in ranges to 200; 2,000; 3,600; 20,000, and 36,000 units.—*Librascope, Inc., 808 Western Ave., Glendale, Calif.*

For more information circle **353** on inquiry card.

Angle-to-digits Converter

New "Shaft Position Quantizer" with its control unit constitutes shaft-position-to-digital converter system; is essentially a simple induction device (no gears or digitizing commutators); is adaptable to any shaft. Four standard models provide divi-

DeJUR high precision panel instruments

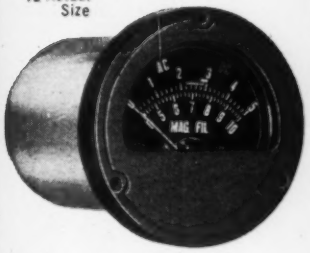
SERIES 100 — Actual Size

1" Sealed Sub-Miniature – Meets smallest weight and space requirements. 9 meters can be mounted in only 3¾" square! Accuracy ± 3% of full scale.

MODEL 131 — ¾ Actual Size

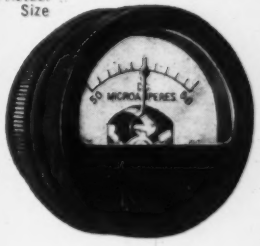
1½" Ruggedized Miniature – Special ruggedized features to withstand heavy duty operation. Sealed windows and terminals.

SERIES 647 — ½ Actual Size



2½" Multiple-Scale—Unique space saver. Provides up to 5 scales in all sensitivities. Sealed housing.

MODEL 150 — ¾ Actual Size

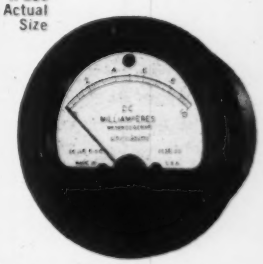


1½" Sealed Miniature—Easy one hole mounting. Sealed windows and terminals. Square model available on order.

Precision instruments by DeJUR provide a combination of compact design, accuracy and high quality. All DC models use external pivot D'Arsonval movements, and are housed in metal cases.

Our engineering department will be glad to help you with special scales, ranges or specifications. For the complete technical data sheets write to Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, N. Y.

MODEL R-230 — ½ Actual Size



2½" Ruggedized or Sealed—Withstands shock, vibration and temperature extremes. Sealed windows and terminals. Also available in 3½" size.

SERIES HD-654 — ¼ Actual Size

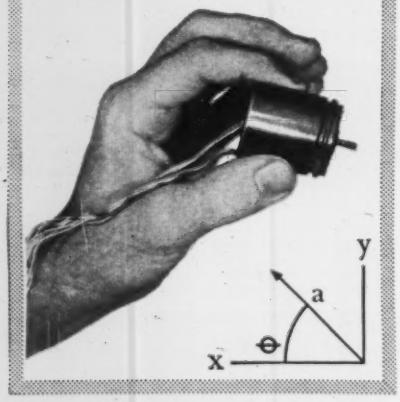
3½" Elapsed Time Indicator—Easy to read 5 digit counters can be provided to register tenths of minutes or hours.

you're always sure with DeJUR

For more information circle **79** on inquiry card.

TELESYN® 400 CYCLE RESOLVERS

from FORD INSTRUMENT



- **STANDARD RESOLVERS** in Sizes 15, 23 and 31
- **RESOLVER SYSTEMS** incorporating size 23 or 31 resolvers, network box and amplifier.
- **and SPECIALS** designed to the particular application.

Ford Instrument's *Telesyn* Resolvers – precision-built for the extreme efficiency and accuracy of the Company's computers and control systems – are available to meet your *own* quality requirements.

FREE – Fully illustrated data bulletin gives specifications and performance information. Please address Dept. IA.

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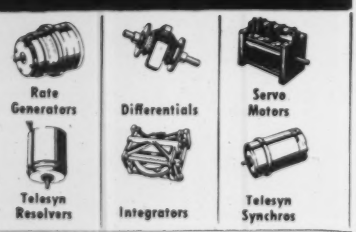
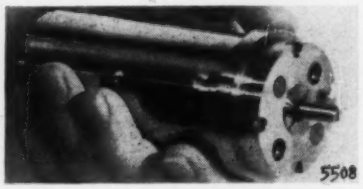
FORD INSTRUMENT COMPANY
Division of Sperry Rand Corporation
31-10 Thomson Ave.
Long Island City 1, N. Y.

Ford Instrument's standard components



For more information circle **80** on inquiry card.

NEW INSTRUMENTS

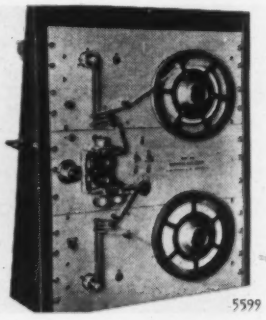


sions from 320 to 4096 per turn. (Larger models for resolution above 4096 per turn.)—*The Austin Co., Special Devices Div., 76 Ninth Ave., New York 11, N. Y.*

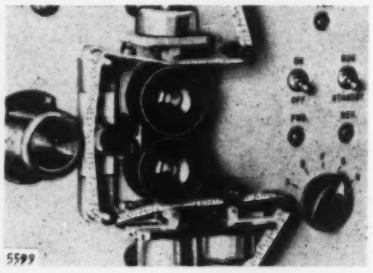
For more information circle **354** on inquiry card.

Tape Reader

New "Model 903 Perforated Tape Handler" features start and stop times of 5 milliseconds, tape speeds up



to 60 inches per second, character readout up to 600 per second. Its ability to stop almost instantly obviates

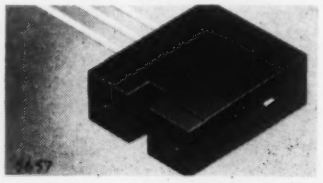


need for slowing down before stopping, thereby increasing its efficiency. Various models handle tape widths from 11/16 in to 1 in and 5- to 8-channel tape.—*Potter Instrument Co., 115 Cutter Mill Rd., Great Neck, N. Y.*

For more information circle **355** on inquiry card.

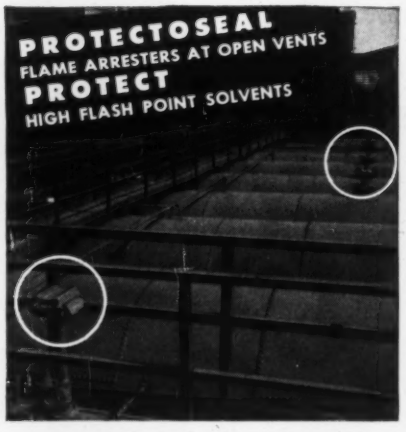
Read and Record Head

New "Model MH 10-A," specifically designed for low-cost recording or reading on magnetic drums in memory systems of digital computers, is said to feature simplicity of design, flexi-



bility of operation, high readback signal, low noise, high voltage insulation, dimensional stability without shrink or swell, and accurate alignment of gap.—*Librascope, Inc., 808 Western Ave., Glendale, Calif.*

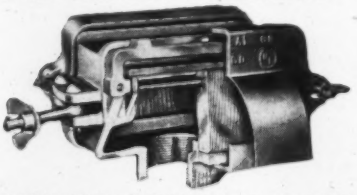
For more information circle **356** on inquiry card.



STORAGE TANK INSTALLATION AT EASTERN BY-PRODUCT BENZOL PLANT COMBINES

Maximum Air-Flow Capacities
Positive Fire Protection
Low-Cost Maintenance

Protectoseal Series No. 860 Non-Conservation Type Vents installed on the large, horizontal storage tanks of this By-Product Benzol Plant provide maximum air-flow consistent with operating efficiency, positive fire protection and effective low-cost maintenance.

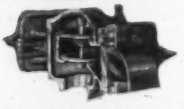


LIGHT WEIGHT, PRESSURE-TIGHT HOUSINGS
Combine ease of installation with durability. Housings meet hydrostatic pressure tests by Underwriters' Laboratories.

POSITIVE FIRE PROTECTION
Sturdy Protectoseal rectangular plate type flame arrester protects tank contents by preventing the propagation of fire and explosion into tank. Easily accessible for cleaning without disturbing original factory alignment.

LOW-COST MAINTENANCE
Modern swing-bolt design permits quick removal of vent covers and weatherhoods for visual inspection or cleaning.

VAPOR CONSERVATION TYPE VENTS



Similar in design to the Non-Conservation Vents but incorporate relief valves in the vent housing which conserve vapors to reduce costly evaporation losses. Valves retard intake of air and escape of vapors as tank normally breathes in and out.

IN-LINE VENTS

An exclusive Protectoseal design approved for installation at varying distances from open end of vent pipe. Suitable for inside tank house installations on storage or processing tanks, bleed lines, bleed tanks or other waste gas lines.

PROTECTOSEAL MANUFACTURES ALL TYPES OF FLAMMABLE LIQUID STORAGE TANK VENTING AND OPERATING EQUIPMENT:
NON CONSERVATION TYPE VENTS • FLAME ARRESTER RODDING OPENING UNITS • VAPOR CONSERVATION TYPE VENTS • STEAM TRACED VENTING EQUIPMENT • FLAME ARRESTER FILL OPENING UNITS • LOADING AND UNLOADING DEVICES

In Canada: Safety Supply Co., Toronto
The Protectoseal Company,
1954 S. Western Ave., Chicago 8, Ill.

Please send me "Venting Fundamentals"

Name_____ Title_____

Company_____

Address_____

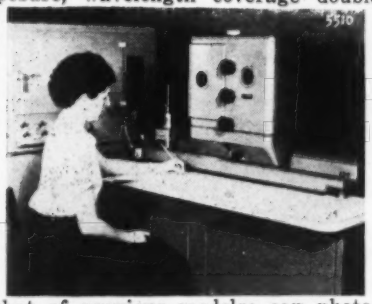
City_____ Zone_____ State_____

For more information circle **81** on inquiry card.

LABORATORY

Three-meter Spectrograph

New model 3-meter concave grating spectrograph provides, in a single exposure, wavelength coverage double



that of previous models; can photograph more of the spectrum in one exposure, at high dispersion, "than any other concave grating spectrograph commercially available." Its 20-in camera utilizes two 10-in plates mounted side-by-side in plateholder, whence operating flexibility of two emulsion types. Shifting from one wavelength to another is rapid and precise; does not require repositioning of lenses and source.—*Baird Associates, Inc., 33 University Road, Cambridge 38, Mass.*

For more information circle **357** on inquiry card.

Temperature Controller for Lab Baths, etc.

New "Thermotrol" is an extremely sensitive and accurate temperature controller, of ac Wheatstone bridge type, using two 12AX7 tubes and one

thyratron. Resistance type primary elements have characteristic times of less than one second. Range: –70 to 200° C for liquid baths and –70 to 300° C for air baths (others will be available). Feature: instrument can be used as on-off controller, proportional controller, or proportional with reset, by turning a switch. Instrument's own 0.001 C° sensitivity calls for optimal design of baths.—*Hallikainen Instruments, 1341 7th St., Berkeley, Calif.*

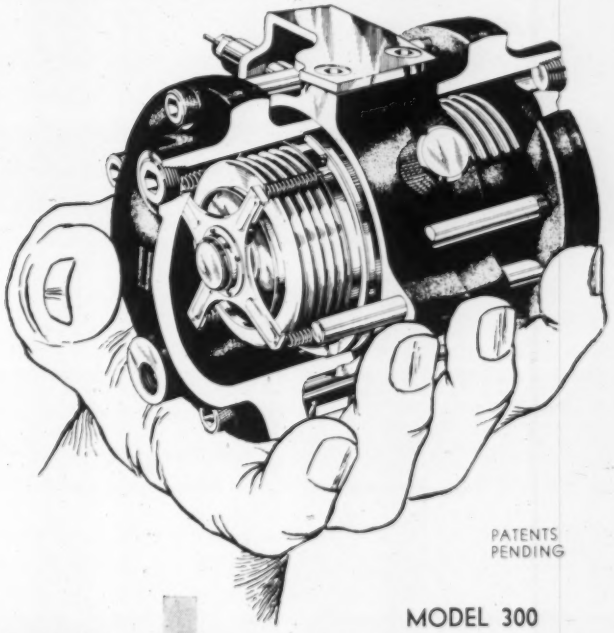
For more information circle **358** on inquiry card.

Automatic Titrator

New "Sargent-Malmstadt Automatic Titrator" embodies H. V. Malmstadt's second-derivative method for potentiometric titration (*Anal. Chem.*, Vol. 26, p. 1348); is said to "exceed any present method or equipment in accuracy, precision, speed and simplicity of manipulation in the hands of technicians"; can be used also in research work investigating new reactions. Outlet is furnished whereby

NEW I.I.C. miniature Dp unit

only 4" x 5" with all the features of larger meters standard ranges in inches of water and p.s.i.



PATENTS PENDING

MODEL 300

I.I.C.-Moore Transmitter Model 300-MT

6" Dial Model 400-6
Also available with 3" dial (Model 400-3)

This new miniature D/P Unit is a scaled-down version of I. I. C.'s full-size flow meter, incorporating all the I. I. C. features and advancements which have met with international success in bellows type flow meters.

- **Compact, light weight, easy to install**
- **Seamless bellows, type 316 Stainless or Monel**
- **Pulsation dampener adjustable externally under pressure**
- **Compensation for ambient temperatures**
- **Overrange protection to housing rating**
- **Furnished in all standard differential ranges in inches of water and p.s.i.**
- **Forged steel housings, alloy or 316 stainless steel. Working pressures 1000, 2500 and 5000 p.s.i.**

It's the only meter of its size with all big-meter features.

For full information—including the name of your nearest representative, write for Bulletin 56-B-2.

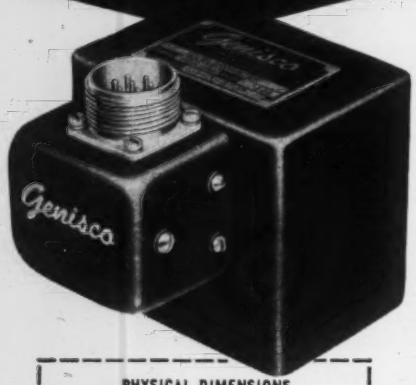
IIC®

INDUSTRIAL INSTRUMENT CORP.

DRAWER 152 ODESSA, TEXAS

For more information circle **82** on inquiry card.

Genisco's New GOH Accelerometer
WITHSTANDS VIBRATIONAL ACCELERATIONS
of 15 G's up to 2000 cps



PHYSICAL DIMENSIONS

OVERALL HEIGHT	3 1/16"
OVERALL WIDTH	3 1/4"
OVERALL DEPTH	3 3/4"
WEIGHT	38 OUNCES

Hermetically sealed

This newest Genisco Accelerometer is a rugged, oil-damped, potentiometer-type instrument designed to operate in the most severe missile and aircraft vibrational environment. For example, in a recent production test the GOH performed satisfactorily after vibrational environment of 15 G's up to 2000 cps. As further proof of its ruggedness, the GOH will withstand 40-G shocks of 5 millisecond duration on the sensitive axis, and steady-state accelerations of 30 G's on the non-sensitive axes and 10 G's on the sensitive axis without damage.

HEATING ELEMENT AVAILABLE—A thermostat-controlled, internal heater may be installed in the GOH to keep operating characteristics constant between −50° F. and +160° F. However, thermostat operation is limited to 60,000 feet or less, 95% relative humidity at 160° F., and a vibrational environment of 10 G's up to 500 cps.

SPECIFICATIONS

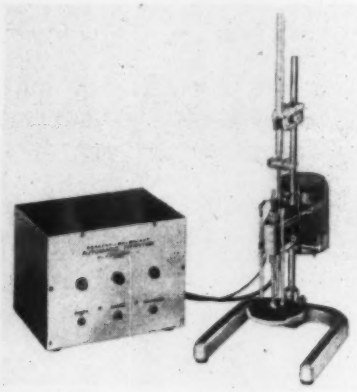
Ranges: ±1 G to ±3 G's inclusive.
Natural Frequencies: 7 cps. to 12 cps.
Nominal Damping: 0.65 of critical at 75° F. Values between 0.4 to 1 set if desired.
Resistance: 14000 ohms (±5%); center tap at 0 G-point. Other resistances also supplied.
Potentiometer Voltage: Up to 60 volts.
Resolution: One part in 300 for standard potentiometer.
Noise Levels: Less than 10 mv at 0.1 ma brush current.
Linearity: Within 1% of full scale from best straight line through calibration points.

Complete technical data on the GOH and other Genisco Accelerometers and Pressure Transducers is available from Genisco, Incorporated, 2233 Federal Avenue, Los Angeles 64, California. Write for your copy today.

RELIABILITY FIRST

Genisco INCORPORATED

For more information circle **83** on inquiry card.

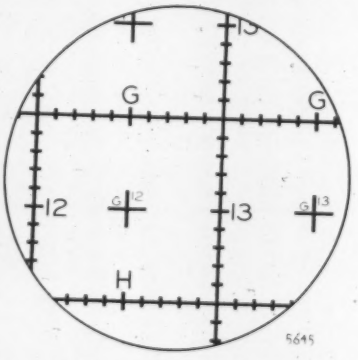


second derivatives can be recorded during titrations. Instrument is fully automatic: it not only shuts off burette at end point, but also determines this end point without requiring preselection of voltage or predetermination of proper point for shutoff.—*E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.*

For more information circle **359** on inquiry card.

Micro-slide Field Finder

New Lovins Micro-Slide Field Finder enables microscopist to relocate

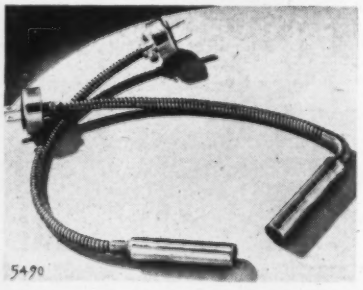


fields of interest in a slide-mounted specimen.—*W. & L. E. Gurley, Troy, N. Y.*

For more information circle **360** on inquiry card.

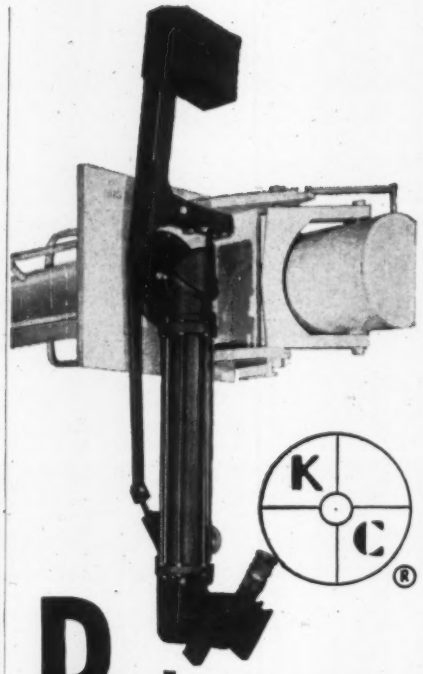
Cartridge Heaters

New improved models of "Chromalox" electric cartridge heaters feature new rust-proof flexible brass conduit



providing positive protection to entire length of lead wire.—*Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.*

For more information circle **361** on inquiry card.



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A custom designed industrial periscope is very often the answer to "Hot Spot" remote control handling, instrumentation and observation. We have designed and manufactured many such periscopes.

If you have a problem calling for a periscope or for any precision optical system, check with us. For nearly half a century Kollmorgen has designed, developed and manufactured precision optical products including Industrial and Naval Periscopes, Fire Control Devices, Projection Lenses and Navigational Instruments for Industry and for the Armed Services.

Send for Bulletin 301

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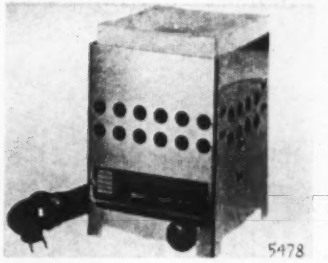
Plant: 347 King Street, Northampton, Mass.
New York Office:
30 Church Street, New York 7, New York

For more information circle **84** on inquiry card.

Laboratory Heater

Newly redesigned "Type RH" laboratory heater has a built-in lateral rheostat. Temperatures are reproduc-

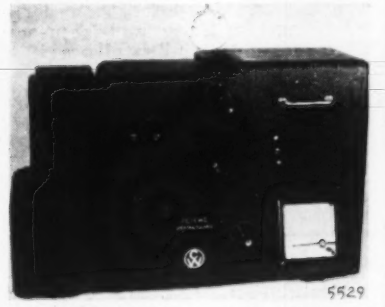


ible by means of a reference scale (bottom of front) graduated 0 to 100 (275 to 550 watts).—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **362** on inquiry card.

Spectrophotometer for Color Comparisons

New "Spectrapolarid" rapidly measures intensity of colors of transparent substances so that shades may be



duplicated exactly.—*Industrial and Scientific Products Div., Curtiss-Wright Corp., Caldwell, N. J.*

For more information circle **363** on inquiry card.

Portable Viscometer

New "Portable Coaxial Cylinder Viscometer" is a new embodiment of Couette coaxial cylinder principle, de-

signed to overcome many disadvantages of earlier types.—*Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N. Y.*

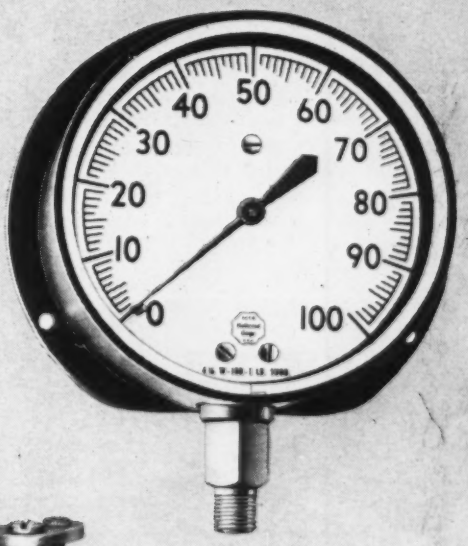
For more information circle **364** on inquiry card.

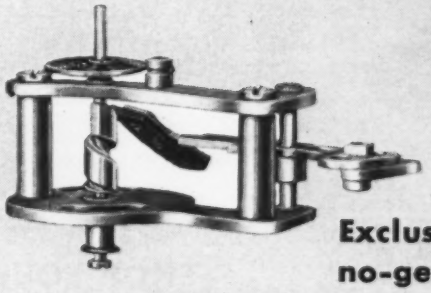
Film Viewers

Two new 70-mm photo-fluorographic film viewers for mass radiography will permit reading a large number of negatives over a long period of time while

an ACCO product

Helicoid Gages





Exclusive HELICOID no-gear movement

For day-in, day-out Sustained Accuracy —for the life of the gage— HELICOID Quality costs you less!

• It's the basic design of HELICOID Gages that makes them outlast and out-perform ordinary gear-tooth gages. This enduring accuracy is evidenced by the smooth rotation of simple spiral roller and cam.

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Dials may be black, white or radiant.

Wall or stem mounting cases—flush panel or flangeless cases.

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For more information circle **85** on inquiry card.

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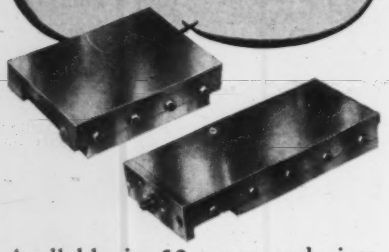
with these
Standard COMPONENTS
FOR Special MACHINES

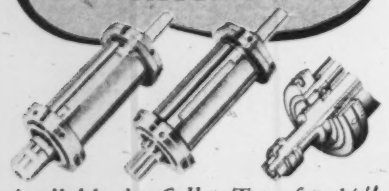
COMPLETE your *special* production equipment faster with *standard* components from this extensive line. Highest precision and quality—many sizes available from stock. *Get complete details!*

STANDARD
Slide
ASSEMBLIES



Available in 52 types and sizes. *Basic Type* includes male and female members, gib and gib screws. *Assembled Type* also has return springs, stop screw, Neoprene shield and mounting holes. Sliding surfaces furnished either *Milled* or *Hand Scraped.* Widths from 2″ to 6″—lengths from 3″ to 16″.

STANDARD
Spindle
ASSEMBLIES



Available in *Collet Type* for ⅛″, 3/16″ and ¼″ max. capacity collets; *Morse Taper Type* for No. 0 and No. 1 Morse taper shanks; and *Arbor Type* for shankless cutters with 0.375″ and 0.500″ center hole. *Standard Duty* has single row ball bearings at both ends; *Heavy Duty* has double row bearings at front.

WRITE now for FREE catalog!

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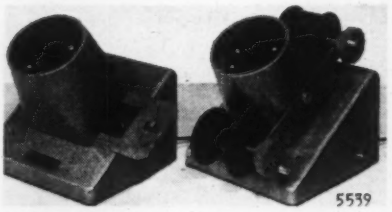
1248 Milton Ave.
JANESVILLE, WISCONSIN

For more information circle **86** on inquiry card.

NEW INSTRUMENTS

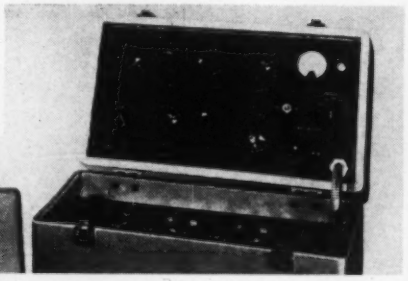
minimizing eye fatigue. One model is for viewing roll film, the other for cut film. In any viewing position, observer looks at reflected light only—never directly into lamp.—*Fairchild Camera & Instrument Corp., Robbins Lane, Syosset, L.I., N.Y.*

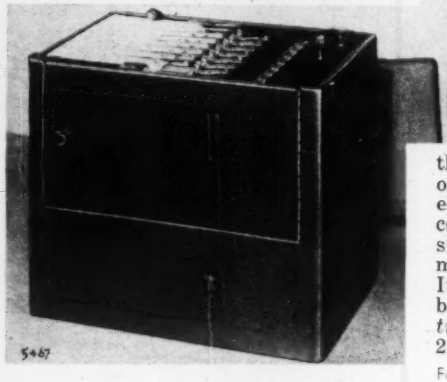
For more information circle **365** on inquiry card.



Portable Electroencephalograph

New "Type T," said to be "the world's first transistorized portable electroencephalograph," is housed in two suitcase type cases; is said to be simpler to operate, less susceptible to outside interference, and more stable than vacuum-tube EEGs. Although one-tenth the size of laboratory models, "Type T" has channels for recording eight signals from the brain simultaneously; surpasses many large models in sensitivity and accuracy. Instrument's portability allows it to be brought to patient.—*Offner Electronics,* 5320 *N. Kedzie Ave., Chicago* 25, *Ill.*





For more information circle **366** on inquiry card.

SHOP EQUIPMENT, AUTOMATION

Paste Solder

New "Lotemp" paste solder can be used on electrical and electronic equipment without risk of corrosion problems arising from flux residue; will cling to surfaces other than horizontal; can be applied with brush, spatula or hypo-needle to hard-to-get-at places. —*Mico Instrument Co.,* 86 *Trowbridge St., Cambridge* 38, *Mass.*

For more information circle **367** on inquiry card.

Automatic Assembler for Printed-wire Boards

New "Minn-A-Matic," a single-head multi-purpose automatic assembly machine for electronic production, can accommodate printed wire boards ranging in size from 1 x 1 in to 12 x 17 in and up to ¼ in thick. Boards are run vertically through machine; boards can be inserted manually or

Automation Study Kit

New "Work Simplification and Automation Study Department Package" is designed to show application of maker's "Work Center System" which is said to be "the only standardized approach to straight-line production and practical automation." Kit contains everything necessary to bring 3 power circuits and 3 piped facilities to every work position; to monitor and control individual power circuits; to transport material between operations; to deliver finished work from final operation; to perfect individual bench operations and coordinate them to work in straight-line flow; etc.—*Alden Systems Co., Westboro, Mass.*

For more information circle **368** on inquiry card.

Here's help in making

INSTRUMENT TUBING INSTALLATIONS

FASTER AND MORE ECONOMICALLY.

for Metal Tubing

IMPERIAL *Hi-Duty*® TUBE FITTINGS

Reduce Installation Time 36 to 77%

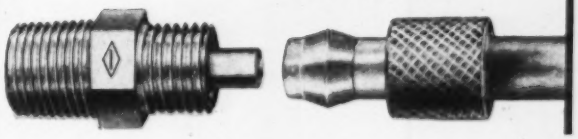
To make a joint you simply push tube into HI-DUTY FITTING and tighten nut. This enables you to save up to 77% in installation time. Nut and sleeve are one piece. Sleeve shears off and becomes attached to tubing in assembly, assuring perfect sleeve alignment. For tubing 1/8" to 1" O.D. Ask for Bulletin No. 3002-A.

for Plastic Tubing

IMPERIAL *Poly-Flo* TUBE FITTINGS and Polyethylene Tubing

Simplify Installation . . . Make Possible Tremendous Labor Saving

Ease of assembly and installation make Poly-Flo Fitting and plastic tubing ideal for instrumentation, panel boards, laboratory equipment, etc. Fittings need only be finger tightened. Tubing is flexible and bends readily by hand. Fittings and tubing furnished in 1/4", 5/16" and 3/8" O.D. sizes. Ask for Bulletin No. 3025.



for Valving

IMPERIAL FLUID CONTROL VALVES

NEEDLE VALVES
Straight and Angle Types

Designed for maximum dependability; easy operation.

TOGGLE VALVES

Quick operating; shows at a glance whether open or closed.

PACKLESS DIAPHRAGM VALVES

For positive control of pressure and vacuum. Solid Teflon diaphragm.

HI-DUTY VALVES

Plug Type. 2, 3 and 4-way styles.

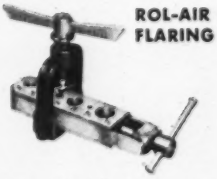
for Tubing Work

IMPERIAL TUBING TOOLS

HI-DUTY TUBE CUTTER

Free wheeling ball bearing action. Roller type with flare cut-off groove. Retractable reamer. **No. 274-F** for 1/8" to 1" O.D. hard or soft tubing.

ROL-AIR FLARING TOOLS



Flares and then automatically burnishes flares. Makes stronger flares, assures tighter joints. **No. 507-F** for 37° flares. Flares 3/16", 1/4", 5/16", 3/8", 1/2", and 5/8" O.D. tubing.
No. 500-F for 45° flares.

BLUE DOT TUBE BENDERS

Bend hard or soft tubing. Form neat accurate bends to short radius. Calibrated. **No. 364-F.** Individual benders for each size of tubing 3/16" to 3/4" O.D. Also many other tools.

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Pioneers in Tube Fittings and Tube Working Tools

For more information circle **87** on inquiry card.

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versatile...fast...
low cost
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GENERAL PURPOSE
COMPUTER

AUTOMATION EXPOSITION
CHICAGO

The Bendix G-15A stored program digital computer will be in operation at the Automation Exposition for your inspection.

This computer is well suited to the design, analysis and control of Automatic Control Systems. It performs all fundamental arithmetic operations and, in addition, is capable of making decisions.

The G-15A is one of the lowest priced general purpose computers available and is unusually compact. It is in production.

Bendix Computer

ON DISPLAY—Booths 445-446
AUTOMATION EXPOSITION
NAVY PIER, CHICAGO, NOVEMBER 14-17

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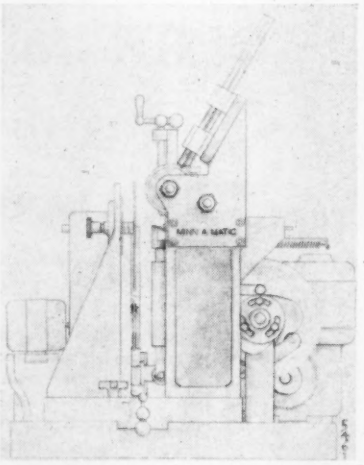
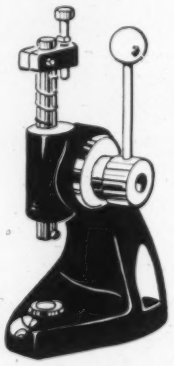


automatically. Feature is elimination of pre-punching or pre-drilling of holes for axial lead components, which can range in size from diodes to 1 ufd capacitors. Angle between wire clinch and components' body is adjustable throughout 360°. Adjustments provide for any desired length of lead bend, and for varying length of clinched tab. —*Minnesota Engineering Co., 43 Royalston, Minneapolis 5, Minn.*

For more information circle **369** on inquiry card.

Midget Arbor Press

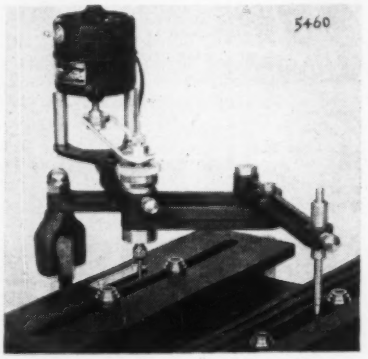


New rack-and-pinion arbor press is 8 in high, has accurately aligned no-loose-play spindle and adjustable stop. Spring action returns spindle to initial position. Press is said to be especially useful for instrument department work such as broaching small holes and keyways, punching, forming, crimping, staking instrument parts, etc.—*A. R. Fineisen, 114-102 230th St., Cambria Heights 11, N. Y.*

For more information circle **370** on inquiry card.

Engraver Pantograph

New "No. 623" fixed 3:1 ratio pantograph (shown attached to maker's standard engraver components) is

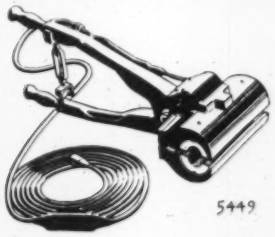


built to same exacting requirements as "No. 600" multi-ratio pantograph and utilizes same type of cutters and accessories.—*Mico Instrument Co., 86 Trowbridge St., Cambridge 38, Mass.*

For more information circle **371** on inquiry card.

Cable Vulcanizer

New electrically-operated cable vulcanizer weighs 16 lbs., less molds, yet can repair cable up to 2 in; is available for use on standard ac and



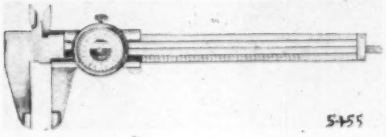
dc sources; wattage rating 1000; can make quick on-the-job jacket repairs or completely replace insulation and jacketing when splices are required. Available aluminum molds cover most standard and many special types of cord and cable.—*Dept. C-40, Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Penna.*

For more information circle **372** on inquiry card.

DIMENSIONAL

Dial-reading Calipers

New chromium-steel calipers designed for easier reading of vernier scales or graduations on micrometer

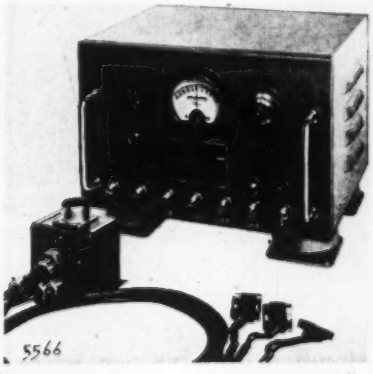


sleeve, have dials reading to 0.001 in or 0.1 mm (0.05 mm can be easily estimated.—*Lux Scientific Instrument Corp., 935 Broadway, New York 10, N. Y.*

For more information circle **373** on inquiry card.

Dynamic Shaft-eccentricity Micrometer

New "Mutual Inductance Micrometer," originally manufactured for US Navy and tested by National Bureau of Standards, measures dynamic clearance of a rotating shaft, thereby



INSTRUMENTS INDUSTRY NEEDS

Hycon engineering skill and design keep pace with ever-changing industry, producing instruments that anticipate need—designed to simplify and speed production. Depend on Hycon for electronic testing equipment.

MODEL 625 DIGITAL RATIOMETER

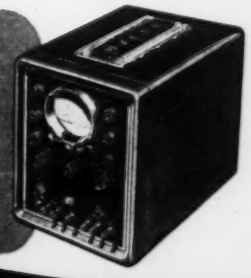
Measures ratio of two DC voltages where one is derived from the other. Ratio is displayed on a three digit servo-positioned counter. Provides a discreet indication of one part in a thousand. Slewing time is less than 4½ seconds full scale. The response is critically damped. $550.00

MODEL 615 DIGITAL VTVM

Ideal for production-line testing and the laboratory, this new VTVM gives direct readings, without interpolation. Features illuminated digital scale with decimal point and polarity sign... 12 ranges (AC, DC, ohms)... response with auxiliary probe to 250 mc... accuracy: 1% on DC and ohms; 2% on AC. FIELD RUGGEDNESS... LAB PRECISION $374.50

MODEL 617 3" OSCILLOSCOPE

Designed both for color TV servicing and laboratory requirements. Features high deflection sensitivity. (.01 v/in rms); 4.5 mc vertical bandpass, flat within ±1 db; internal 5% calibrating voltage. Small, lightweight... but accurate enough for the most exacting work. SPECIAL FLAT FACE 3" CRT PROVIDES UNDISTORTED TRACE EDGE TO EDGE. $269.50



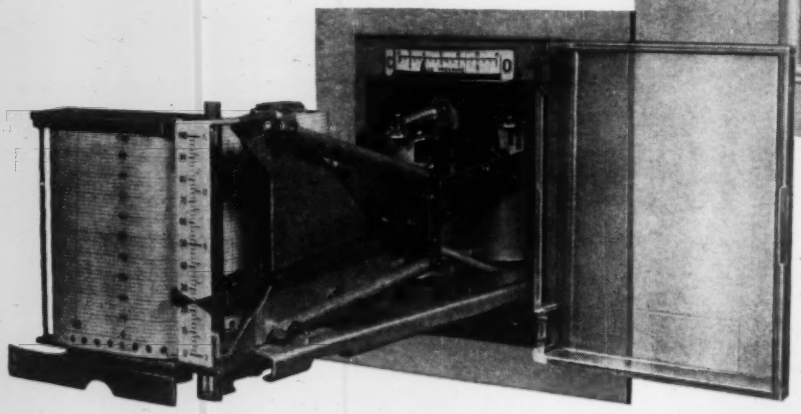
Write for catalog sheets and detailed specifications of any of the instruments shown above – or for complete list of Hycon field testing equipment.

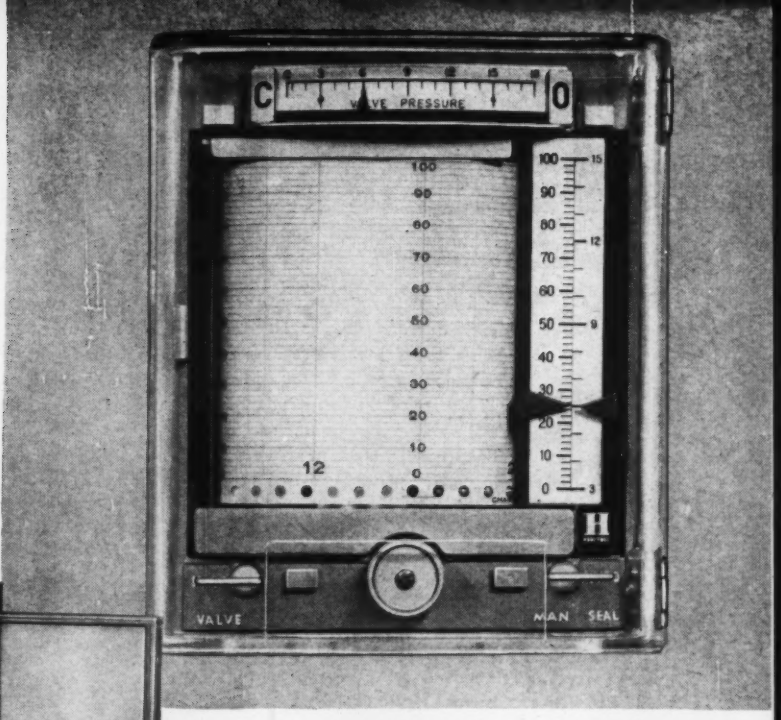
Hycon Mfg. Company
2961 East Colorado Street
Pasadena 8, California
"Where accuracy counts"
ORDNANCE · ELECTRONIC TEST INSTRUMENTS
ELECTRONIC SYSTEMS · AERIAL SURVEYS
BASIC ELECTRONIC RESEARCH · AERIAL CAMERAS
GO NO-GO MISSILE TEST SYSTEMS

For more information circle **89** on inquiry card.

TEL-O-SET RECORDER

takes panel cut-out only 5-1/32" high by 4-9/16" wide. Chassis slides out of case as a complete unit . . . can be shipped separately to prevent damage and collection of dirt or dust awaiting start-up. In partially withdrawn position, the internal mechanism is accessible for adjustments. Uses identical case as indicator. Bottom-of case location of control knobs permits instrument to be mounted higher on the panel.

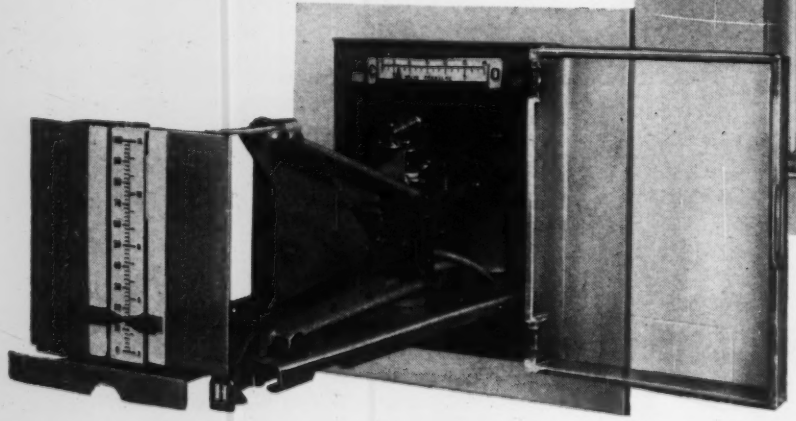


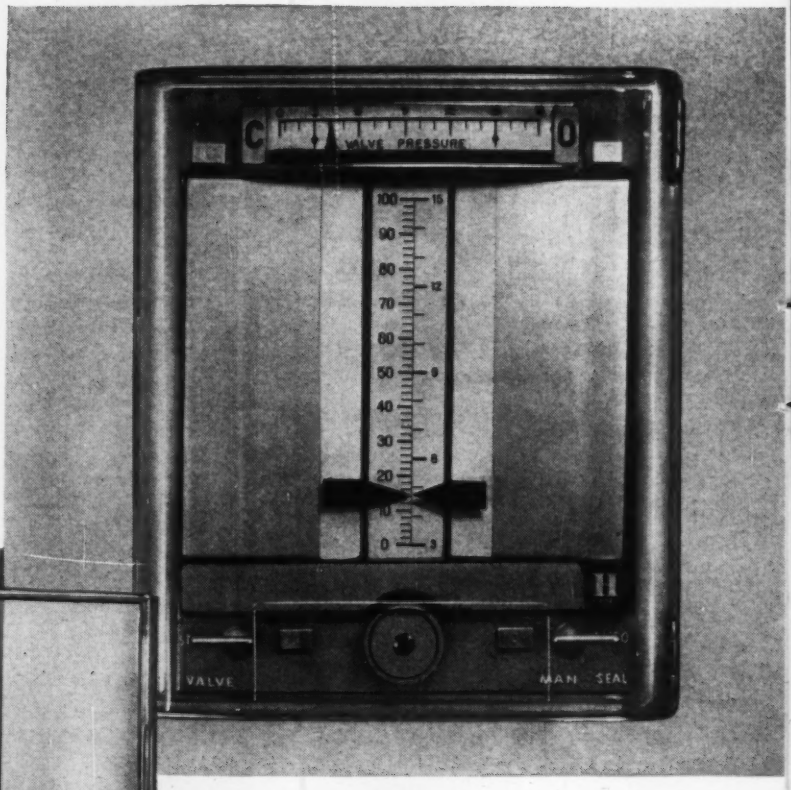


today's

NEW *TEL-O-SET* INDICATOR

takes same panel cut-out as recorder . . . uses many of the same parts. Less spare parts inventory is required. Note the rugged construction, easily accessible calibration adjustments. Vertical scale makes it easy to compare set point and measured value. Recorder and indicator chassis are completely interchangeable.





● **REFERENCE DATA: Write for new Bulletin No. 7202.**

In performance . . .

precision . . .

serviceability . . .

Tel-O-Set instruments

give you extra values

Whenever you're planning graphic process control, plan to take advantage of the extra values built into the latest *Tel-O-Set* miniature instruments. These advanced indicators, recorders and controllers simplify installation, service and replacement problems . . . and give you the top in accurate, flexible performance for controlling temperature, flow, pressure and liquid level.

Installation is easier. Case, chassis and controller are separate units. The case can be shipped separately to the point of installation and fully piped and tested . . . for the air to valve gage, regulator and switch assembly remain with the case. These components are readily removed without need for breaking conduit or electrical connections. Panel shipment is simplified, with chassis and controller going directly to the job.

Service is easier. All major parts of the indicator and recorder are identical and interchangeable. Unitized construction of sub-assemblies permits interchangeability of section of major assemblies. The chassis can be partially or fully withdrawn and remain completely operative. It can be disconnected without losing manual control. Controllers have single-lever, quick-disconnect switch . . . use simple, gasketed, flat, mating surfaces.

Operation is easier. An integral switch provides external reset feedback, air on automatic position or air on manual position of bypass relay . . . permitting use with any force-balance controller of past or present design. Opposing pointers tell the measured value and set point on prominently marked vertical scales. Control knob and transfer switch are conveniently located at the bottom of the case, where the operator can manipulate them without having his hand obscure vision of the pointers and scale.

Precision is high . . . ample for even the most exacting process requirements, with true linear calibration.

For a discussion of applications to your own processes, call your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada. Toronto 17, Ontario.

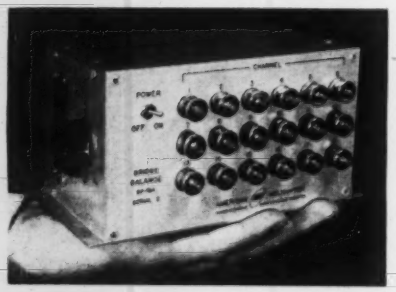
MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

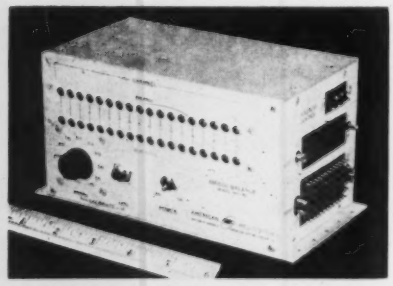
For more information circle **90** on inquiry card.

Miniature Bridge Balance
18 Channels
provides
Balance, Sensitivity Control
and Calibration of
Strain Gages
and Resistance Pick-ups



Model BP-18A Features

- Balance Control
- Fixed Sensitivity Control
- Manual Calibration
- Weight—2.5 pounds
- Size—7 1/8" x 3 1/2" x 3 1/2"



Model BP-18B Features

- Balance Control
- Variable Sensitivity Control
- Automatic Calibration
- Weight—2.5 pounds
- Size—7 1/8" x 3 1/2" x 3 1/2"

Models BP-18A and BP-18B are rugged, precision instruments ideally suited for Laboratory, Field & Flight Test Instrumentation.

- NATIONAL REPRESENTATION

AMERICAN HELICOPTER

DIVISION OF FAIRCHILD ENGINE AND AIRPLANE CORPORATION
COSTA MESA, CALIFORNIA

For more information circle **91** on inquiry card.

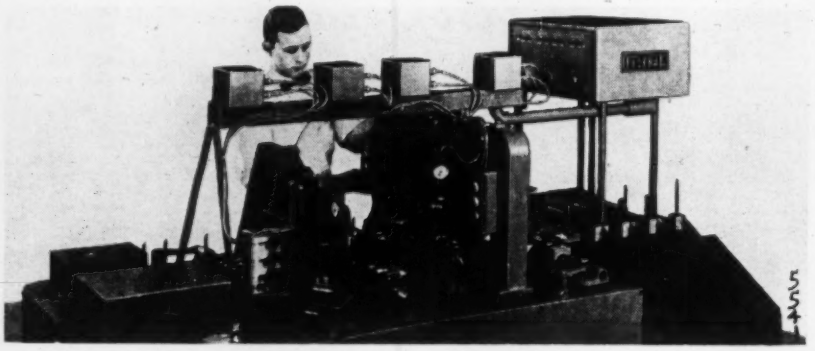
indicating its eccentricities; utilizes mutual-inductance principle which permits detecting of shaft-to-bearing clearances by means of six Mumetal U-shaped probes. Speed limit 6,000 rpm; accuracy 20 microinches; shaft radii 1 to 12 in; probe-to-shaft clearance 2 to 5 mils.—*Minnesota Electronics Corp.*, 133 *E. Santa Anita St., Burbank, Calif.*

For more information circle **374** on inquiry card.

Automatic Gager-classifier

New "Model 144 B-34" fully-automatic four-station in-process sorting gage measures 20 dimensions on 13 different sizes of jet engine stator blades at speeds up to 40 workpieces per minute; rejects offsize parts; allows only good parts to pass on to conveyor.—*Federal Products Corp.*, 1144 *Eddy St., Providence* 1, *R. I.*

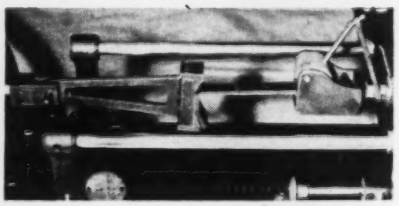
For more information circle **375** on inquiry card.



MECHANICAL TESTING

Adhesion Tester

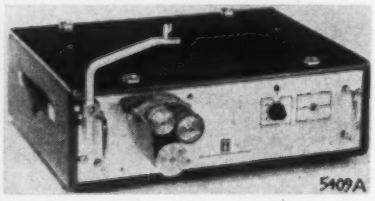
New attachment provides a simplified method of testing adhesion of vulcanized rubber and similar elastomers to metal; uses as specimens inexpensive sheet stock and permits use of usual "Scott Tester" found in rubber labs.—*Scott Testers, Inc.* 45 *Blackstone St., Providence, R. I.*



For more information circle **376** on inquiry card.

Yarn-test Drive

New "BL-850 Four-speed Material Drive" for testing yarn, etc., features uniform speed selected by operator; can be used with any make of evenness testing equipment. Selector switch gives choice of 0.5, 1.5, 5 and 15 fps for driving material under test. —*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*



For more information circle **377** on inquiry card.

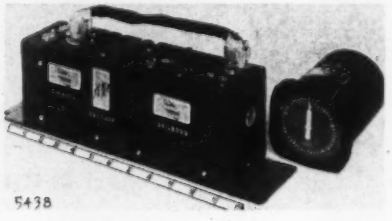
Yarn-test Drive-rewind

New "BL-853 Combination Material Drive and Yarn Rewind" for running test lengths of yarn, sliver or roving can be used with various makes of evenness testing equipment. Rewind unit (desirable where same length is to be retested for establishment of an average) will prepare yarn smoothly and evenly so that it can be readily rerun; operates at constant 5 fps.—*Brush Electronics Co.*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **378** on inquiry card.

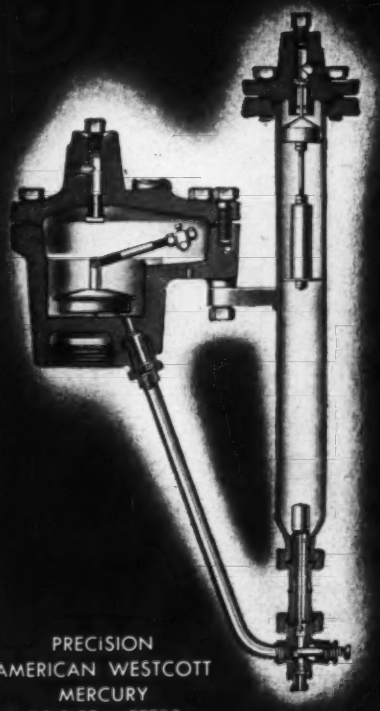
Strain Gage System and Remote Indicator

New self-balancing strain-gage system and direct-reading remote indicator continuously monitors minute strains in structural parts or assemblies of an aircraft. System compo-

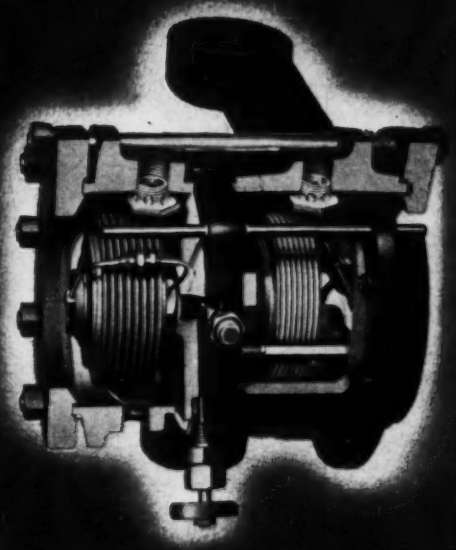


AMERICAN®

offers you TWO BASIC MEASURING INSTRUMENTS



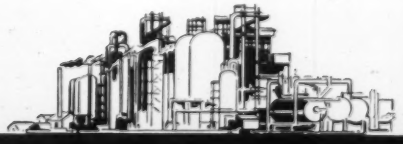
PRECISION
AMERICAN WESTCOTT
MERCURY
ORIFICE METERS

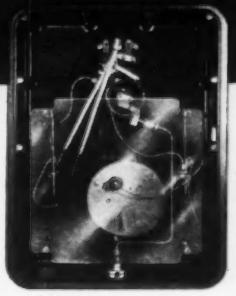


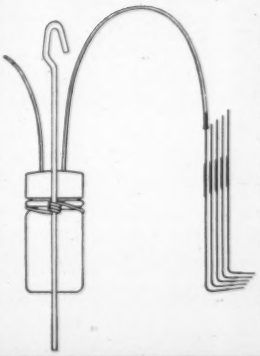
PRECISION
AMERICAN DRI-FLO
MERCURYLESS
ORIFICE METERS

Your specific requirements for differential pressure measurement will be met with one of these two field proven instruments. Both types are designed to reduce installation and operation problems. Both combine the extreme accuracy, dependability and low maintenance characteristic of all American equipment built under a long-time tradition of "Sustained Accuracy at Lower Cost."

Write for Details







CANNON METER PENS
(Formerly Chartomatic)
FOR ALL TYPES OF RECORDING INSTRUMENTS

Now, American and other types of recording instruments may be equipped with Cannon controlled-flow Meter Pens, if desired. Stainless steel pens are capillary fed by upward flow from a half-ounce reservoir holding and protecting up to a year's supply of ink. These instruments provide maximum legibility and reduce meter inking problems to the bare minimum. They are unaffected by pulsating flows, rapid pen movement, or atmospheric fluctuations and are non-clogging. Available in various styles for all standard recording instruments.

AMERICAN METER COMPANY
INCORPORATED ESTABLISHED 1836

AMERICAN METER CO EST. 1836 MEASUREMENT ENGINEERS

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
Albany • Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie
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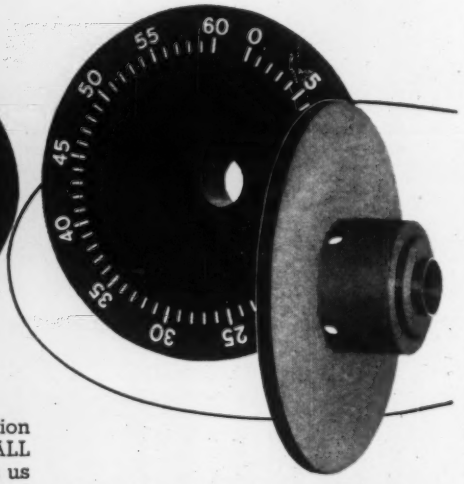
San Francisco
IN CANADA: Canadian Meter Company, Limited
Hamilton, Ontario • Edmonton, Alberta

For more information circle **92** on inquiry card.

PRECISION and ACCURACY in both MARKING and FABRICATION



The United States Radium Corporation is experienced in marking by ALL methods, not just one. This enables us to recommend a marking best adapted to the type of part. These methods comprise photographic reproduction, screening, an improved offset process, etching, engraving, and lithography.

USRC is equally experienced in the fabrication and marking of metals or plastics—for direct reading, edge- or back-lighted, or window type parts.

Accuracy in marking is impossible unless the blank parts are equally accurate. This company has the facilities for very accurate fabrication for all types of parts and for the manufacture of complete dial and indicator assemblies. This accuracy is obtainable in USRC-furnished components.

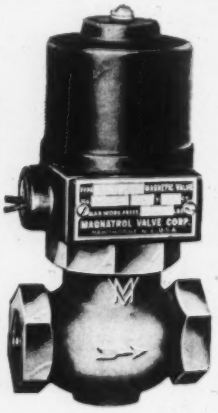
Inquiries invited – address Dept. IA-10.

UNITED STATES RADIUM CORPORATION

Eastern Sales Office—535 Pearl St., New York 7, N.Y.
Western Sales Office—5420 Vineland Ave., N. Hollywood, Cal.
Plants and Laboratories at—Bloomsburg, Pa., Whippany, N.J. Bernardsville, N. J., North Hollywood, Cal.

For more information circle **93** on inquiry card.

Eliminate
Costly Flow Failures



Magnatrol
SOLENOID VALVES

Quick Operating Non Sticking Tight Seating

These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves**. Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory **tested**—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

Catalog containing complete specifications mailed upon request.

Magnatrol VALVE Corp.
HAWTHORNE 14
NEW JERSEY

For more information circle **94** on inquiry card.

nents (only partly shown): potentiometer, servomotor, gear train, indicator, comparator, amplifier, and transmitting synchro. Inherent electrical noise in system is below 20 microvolts; linearity within 0.2%; resolution 0.2%; over-all accuracy better than 1%.—*The Greenleaf Mfg. Co., 7814 Maplewood Industrial Court, St. Louis 15, Mo.*

For more information circle **379** on inquiry card.

Optical Tester

New optical tester is for testing lenses and mirrors for focal length, aberrations, and accuracy of optical figure. By holding (or mounting) tester near focal plane of an optical element, user can obtain a fringe pattern which will vary according to quality of element.—*Ann Arbor Optical Co., P. O. Box 2056, Ann Arbor, Mich.*

For more information circle **380** on inquiry card.

Strain-gage Pickups

Three new standard "SR-4" bonded resistance wire "strain gages" with flat grid, fine pitch, and Bakelite base: "ABF-7" with ¼-in grid length can be used in place of wrap-around type gages of short grid length. "EBDF-7T+" is a self-compensated gage of ¼-in. grid length for use on titanium. "EBDF-13Q+" is a self-compensated gage of ⅜-in grid length for minimum response to temperatures between 50 and 250°F. when cemented to quartz. Bonded to unrestrained members of other material, it would measure thermal expansion stress when temperature-cycled. Alternate "13T+" type gages for titanium and "13Q–" and "7Q–" for quartz are also available.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

For more information circle **381** on inquiry card.

Shaker System

New "Series 8000" 600-lb force shaker system, for vibration testing over 5 to 5000 cps frequency range, features full rated output over entire frequency range, without power factor correction or use of changeable impedance matching taps. Guaranteed frequency response values are ±1 db @ 7 to 2000 cps and ±3½ db @ 5 to 5000 cps, with bare table. Equipment

will operate with single frequency, sweep cycling or complex-waveform input signal. Desired input is switch-selected from a control console.—*The Calidyne Co., 120 Cross St., Winchester, Mass.*

For more information circle **332** on inquiry card.

Rotary Accelerator

New "Model CK9X" acceleration testing machine is capable of subjecting objects as large as 5-in cube weigh-

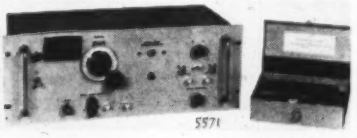
ing a maximum of 3 lb to accelerations up to 250 *G*. Rotating table is tapped with groups of holes to permit mounting, testing and calibrating four objects simultaneously. Tachometer generator and indicator provide continuous speed measurement accurate to 2%. (Optional "Stroboconn" frequency meter accurate to 0.1%.) Single- and four-line pressure and vacuum systems available if desired.—*Schaevitz Machine Works, Camden 1, N. J.*

For more information circle **383** on inquiry card.

ELECTRICAL TESTING

Crystal Impedance Meter

New "Model 991 Crystal Impedance Meter" is designed to test 5-Mc overtone quartz crystals used in primary



frequency standards. Used with an auxiliary standard laboratory VTVM, it measures resonant series and anti-resonant impedance of these crystals. Oscillator circuit suppresses oscillation at undesired frequencies and provides required gain and phase-shift.—*Radio Frequency Laboratories, Inc., Boonton 13, N. J.*

For more information circle **384** on inquiry card.

Pulse Generator

New "MP-85" all-magnetic pulse generator, for commercial radar and for laboratory testing, utilizes saturable reactors instead of thyratrons as discharge devices; is basically a capacitor type pulser in which electric energy storage is achieved by means of a-c-resonant charging and high pulse powers are obtained by

as small as the tube it cools...

ACTUAL SIZE

EAD's subminiature CENTRIFUGAL BLOWER

Here is the most compact centrifugal blower unit made . . . EAD's high-velocity subminiature centrifugal blower is only 2⅞" long, weighs only 6 ounces, yet it can move 13 cfm of air at a velocity of 3,000 feet per minute—and the volume holds up at high static pressures. It is driven by EAD's new one-inch diameter motor. The metal blower housing can be rotated to any position desired for maximum efficiency in cooling radar equipment, amplifier units, transmitter equipment, oscillators, and in other applications where high temperatures in confined areas demand miniaturized blowers with the highest possible performance characteristics. EAD's subminiature blower units meet all applicable MIL specification, and low temperature rise makes them suitable for high altitude and high ambient temperature operation.

CFM	13 @ 0" SP 10 @ 1.0" SP	7 @ 0" SP 5 @ 2" SP
MAX. SP.	2.5	0.6
RPM	20,000	11,000
AMPS	0.1	0.06
WATTS	10.0	6.0
CAPACITOR Mfd/Volts	0.25/220	0.1/220
WEIGHT (OUNCES)	6	6
MODEL NO.	B2GOU-C	B2HOU-C

Modifications of standard models or completely new designs can be engineered to meet your special cooling needs. Write for complete information.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS · CENTRIFUGAL BLOWERS · TACHOMETER GENERATORS · FANS · ALTERNATORS · GEAR MOTORS

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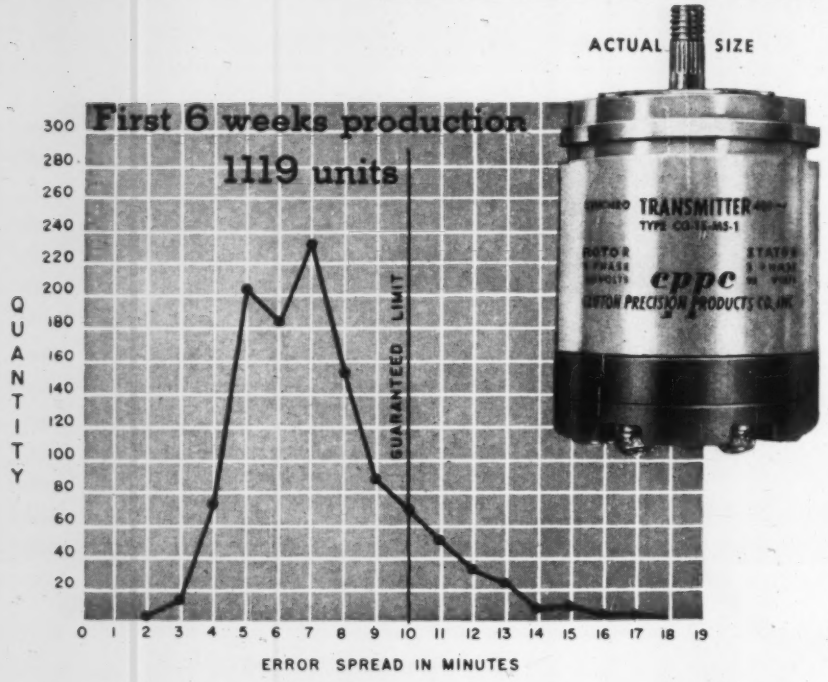
For more information circle **95** on inquiry card.

CLIFTON PRECISION OFFERS A SIZE 15 SYNCHRO TRANSMITTER

identical to BuOrd type 15CX4a

Except

ACCURACY SPREAD GUARANTEED 10′ or LESS



The CG-15-MS-1 transmitter is interchangeable part for part with the U.S. Navy Bureau of Ordnance type 15CX4a synchro transmitter (Mark 22 Mod. 1) in every respect.

Because of quality workmanship in this unit we are able to guarantee accuracy spreads not to exceed 10′. From the chart it will be noted the majority of production units have error spreads between 5′ and 8′—yet price remains exceedingly low.

Stainless steel bearings are provided for better environmental resistance.

FOR SALES INFORMATION, CONTACT:

New England: The Darbury Corp., 99 Elm St., W. Newton 65, Mass.
Southwest: Ammon & Woods Asso., 4163 Glenwick Lane, Dallas, Tex.
West Coast: Enright Engineering Co., 988 W. Kensington Rd., Los Angeles
Home Office: T. W. Shoop, Sales Mgr., Telephone (Phila.) MAdison 6-2101

LOOK TO CPPC FOR SYNCHRO PROGRESS

CLIFTON PRECISION PRODUCTS CO. Inc.

CLIFTON HEIGHTS
PENNSYLVANIA

cppc

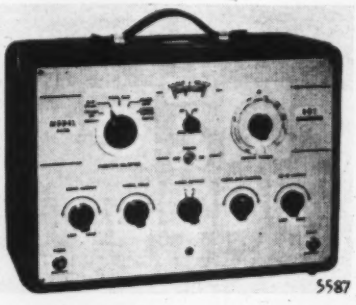
For more information circle **96** on inquiry card.

rapid discharge of capacitor through saturable reactors. By virtue of refined circuitry, pulse repetition occurs only once during a cycle of line frequency, suppressing positive pulse. Furthermore, several stages of basic circuit are cascaded, giving frequency step-up between line frequency and discharge frequency.—*Magnetic Research Corp., 200 Center St., El Segundo, Calif.*

For more information circle **385** on inquiry card.

Dot Generator

New "Model 3438" checks video, RF, IF, sync and color circuits with modulated RF (Channels 2 to 6) and



IF (20 to 55 Mc) outputs available. Horizontal sync pulses (15,750 cps) and vertical sync pulses (60 cps) available for checking sync circuits. —*Triplett Electrical Instrument Co., Bluffton, Ohio.*

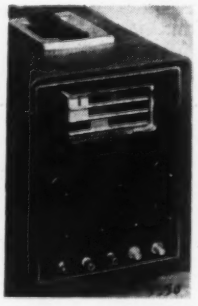
For more information circle **386** on inquiry card.

Signal Generator

New "Model TF-801B" has frequency range of 10-500 Mc, is said to feature long oscillator tube life, output 2 volts, down to 0.1 microvolt, low FM ensured by tuned amplifier, 50-ohm output from piston attenuator calibrated in volts, db and dbm, internal modulation 0-90% metered, external modulation from dc to 3 Mc maximum. Unit has capacity-coupled contactless coil turrets.—*Marconi Instruments, 44 New St., New York 4, N. Y.*

For more information circle **387** on inquiry card

Bar and Dot Generator



New "Model 616" provides every color sequence and linearity adjustment necessary for optimum receiver performance; is suitable for both production-line testing and in-the-home servicing; provides three color sequences each graphically portrayed on front panel; black vertical or horizontal bars or a black cross-hatch pattern with number of bars independently variable.—*Hycon Mfg. Co., 365 So. Arroyo Pkway., Pasadena, Calif.*

For more information circle **388** on inquiry card.

Oeillograph Mounting

New rack mounting for maker's "Type 5-119 Recording Oscillograph, designed to permit use of oscillograph

in ground-mobile installations, finds use also in permanent installations.—*Consolidated Engineering Corp., Pasadena, 15, Calif.*

For more information circle **389** on inquiry card.

Null Indicator

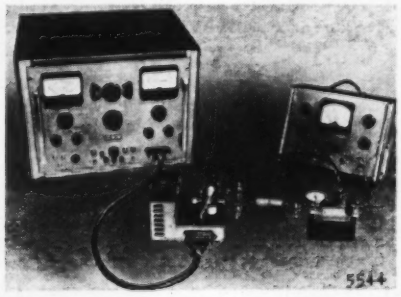
New "Model 2HG-1 Magnetik Null Indicator," said to be "as much as 100 times faster than moving-coil type gal-

vanometers," has extremely low noise level (less than 2 uv) and zero drift of less than one division per hour. Input terminals are completely isolated from chassis and circuit ground, whence versatility.—*Doelcam (Div. Minn. Honeywell), 1400 Soldiers Field Rd, Boston 35, Mass.*

For more information circle **390** on inquiry card.

5-mm Equipment

New line of 5-mm equipment, completely specified, operates over full waveguide frequency range of "RG-98/U" waveguide (50.00 to 75.00 kMc); comprises a slotted section, flap attenuator, tunable detector mount, E/H tuner, frequency meter, termination, sliding short, horn, harmonic gen-



NOW OMNIGUARD...
Can Increase Production
...through low-cost insurance against down time

Whenever conditions call for prolonged, full capacity operation, critical temperatures can cause bearing failure – and result in ruinous shutdowns.

Increased temperature also shortens bearing life expectancy, before causing actual failure – another costly factor in the long run.

This is where the Edison Omniguard comes in – and where it pays its way many times over.

Omniguard's central monitor panel keeps *one* operator constantly posted on bearing temperatures in every plant unit . . . allows running at peak loads with safety.

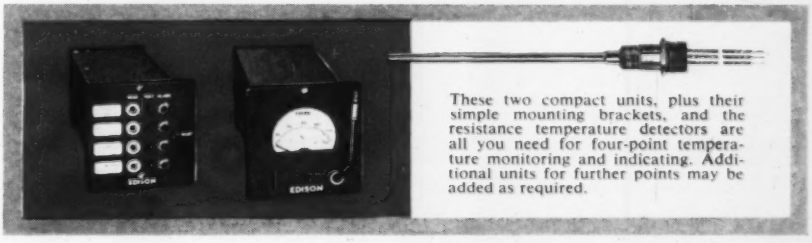
And full capacity operation can be maintained longer – because Omniguard sounds its warning before the damage level is reached.

You can trust Omniguard - because

- Entire system has no moving parts only simple *electrical* circuits, nothing to wear out.
- No adjustments or maintenance necessary – and installation costs are so low because only a minimum of wiring is required.
- Resistance Temperature Detectors are guaranteed accurate to ± 1% – drift less than ± .05%.

And Edison Omniguard costs so little . . . upwards of 50% less than any other monitoring system. This is truly the lowest cost insurance against down time—and Omniguard is so flexible – protects small or large plants with equal ease for an initial investment of less than $500.00.

Write today for article that shows how just a small increase in temperature can cut bearing life in half.



These two compact units, plus their simple mounting brackets, and the resistance temperature detectors are all you need for four-point temperature monitoring and indicating. Additional units for further points may be added as required.

Thomas A. Edison

A GREAT NAME CONTINUES GREAT NEW ACHIEVEMENTS

Thomas A. Edison

INCORPORATED

INSTRUMENT DIVISION • 24 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

For more information circle **97** on inquiry card.

DIALCO

Sub-Miniature PILOT LIGHTS

A great aid to miniaturization

Require a single 15/32" hole

All lens colors

All units applicable to Mil Specifications

when you're CRAMPED for SPACE

A. PLASTIC PLATE LIGHT ASSEMBLIES

B.

C. LIGHT SHIELD ASSEMBLY

D. E. SUB-MINIATURE INDICATOR LIGHTS

A) No. TT-51; No. TT-51A with No. 327 lamp. For edge lighting. Red or other color filters, black top.
B) No. 8-3730-111; for Mil-7788 panels.
C) No. 4-1930; light shield.
D) No. 8-1930-111; non-dimming.
E) No. 11-1930-111; mechanical dimmer. No. 3-1930-111; polaroid dimmer.

All assemblies accommodate midget flanged base lamps like this one *(actual size)*; easily replaced. Available for voltages of 1.3, 2.7, 6, 14, and 28.

Any assembly available complete with lamp.

(All illustrations are approx. actual size.)

SAMPLES ON REQUEST — NO CHARGE

Write for *Catalogue L-153*

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVE. • BROOKLYN 37, N. Y.

HYACINTH 7-7600

For more information circle **98** on inquiry card.

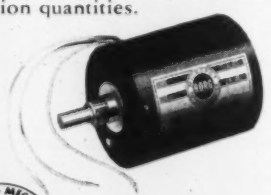
Borg 900 Series Micropots

offer everything you want in a potentiometer

1. Versatility — 1 to 5 gang models, single or double shaft, servo or bushing mount.
2. Permanent Accuracy — Resistance element integrally molded within housing. Leads, taps and terminals firmly encapsulated.
3. Long Life — Scanning action distributes wear across face of bar contact. Rigid, fixed lead screw.
4. Dependability — Mechanically and electrically stable. Effectively sealed against dust and moisture.
5. Absolute Linearity — Uniform resistance distribution. No external trimming required.
6. Specifications — Meets extreme commercial and military requirements for all applications.
7. Availability — Quick deliveries on production quantities.

Borg 1100 Series Micropots

Accurate, dependable, long-lived. Has 9 inch coded leads for easy installation. Offers your products a competitive price advantage.



WRITE FOR CATALOG BED-A15B

BORG EQUIPMENT DIVISION

GEORGE W. BORG CORPORATION

JANESVILLE, WISCONSIN

ELECTRONIC — MECHANICAL BORG EQUIPMENT

Built by Borg

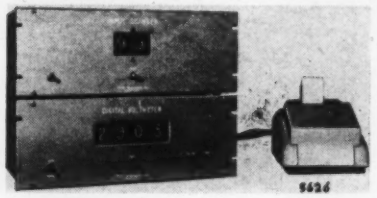
For more information circle **99** on inquiry card.

erator, bends, tees, transmission line stand, klystron tube mount and power supply. Equipment is also available for "RG-97/U" waveguide.—*F-R Machine Works, Inc.*, 26-12 *Borough Pl., Woodside, N. Y.*

For more information circle **391** on inquiry card.

Input Scanner

New "IS100" sequentially selects 100 channels of data. When it is used in conjunction with maker's digital



voltmeters and ohmmeters (and printer), it is said to provide "a complete automation system for component and system testing."—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego* 10, *Calif.*

For more information circle **392** on inquiry card.

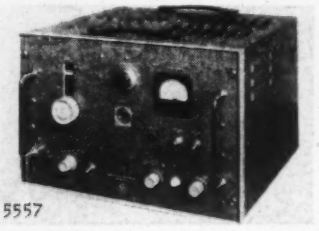
Megohmmeter

New "Model 2030" is a battery-operated version of maker's "1020B" megohmmeter, for measuring leakage resistance from 5 to 10,000,000 megohms in 5 ranges with an accuracy of 3%. A regulated 500-v supply is incorporated for supplying test potential. Readings are obtained instantaneously.—*Freed Transformer Co., Inc.*, 1715 *Weirfield St., Brooklyn* 27, *N. Y.*

For more information circle **393** on inquiry card.

Microwave Oscillator

New "Model 814" frequency generator in X-band region makes use of a discriminator and feedback loop to



5557

secure excellent short-term stabilization (about 0.000,000,05); also features simplified tuning which enables inexperienced personnel to use instrument in routine testing; is applicable to microwave research.—*Laboratory for Electronics, Inc.*, 75 *Pitts St., Boston* 14, *Mass.*

For more information circle **394** on inquiry card.

Five-inch Oscilloscope

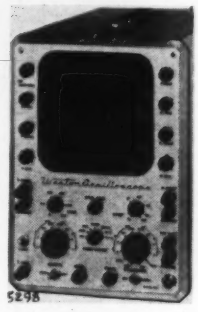
New "Model WO-91A" 5-in 'scope for servicing black-and-white and color television receivers features dual-band response with a 4.5-Mc response in wide-band position; built-in calibration for peak-to-peak voltage measurements; vertical polarity reversal switch for "upright" or "inverted" trace display; pre-set "vertical" and "horizontal" sweep positions for TV

trouble shooting, and shielded vertical-input connector and shielded cable for minimizing hum and stray field pick-up.—*Radio Corporation of America, 30 Rockefeller Plaza, New York, 20, N. Y.*

For more information circle **395** on inquiry card.

All-purpose Oscilloscope

New "Model 983" high-gain wide-band 'scope is designed to accurately reproduce wave-forms comprising a wide band of frequencies; features high sensitivity (15mv/in); contains identical vertical and horizontal push-pull amplifiers with a choice of a-c or d-c coupling without affecting either sensitivity or bandwidth. Excellent square wave reproduction (overshoot 2 to 5%, rise time 0.1 usec). Usable to 6 Mc.—*Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*

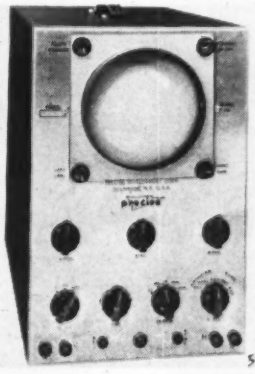


5298

For more information circle **396** on inquiry card.

Five-inch Oscilloscope

New low-priced all-purpose "Model 315" is said to have "numerous outstanding advantages"; features frequency-compensated vertical and horizontal attenuators with identical vertical and horizontal amplifiers.—*Precise Development Corp., Oceanside, L.I., N. Y.*



5477

For more information circle **397** on inquiry card.

Miniature Oscilloscope

New "Type 331" is particularly suited for field or lab testing and servicing of electronic computers, is

5624

TWIN POCKETSCOPE

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RAYONIC® Cathode Ray Tubes
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For more information circle **100** on inquiry card.

Industrial Mass Spectrometry

Here's how it pays off in sulfur recovery

By reporting around-the-clock on the concentration of H_2S and SO_2 in sulfur-extraction plant tail gas, CEC's Type 21-610 Mass Spectrometers pay off in two important ways. By means of its continuous, accurate monitoring, the ratio of the two gases in the stream can be controlled within critical limits, which increases the profitable elemental sulfur output by as much as *1½ tons per day* in a typical plant. And, important to community relations, air pollutants are reduced to an absolute minimum, for when the ratio is just right, the release of harmful, irritating sulfur compounds to the atmosphere is practically eliminated.

Now... two process-monitoring mass spectrometers

For monitoring and controlling streams to mass 80

TYPE 21-610 is moderately priced and a truly general-purpose instrument. Although primarily designed for continuous petroleum and petrochemical stream analysis, it is also valuable for production-line leak detection or laboratory analysis. Its applications have ranged from on-the-spot acetylene-plant monitoring to hospital clinical tests on lungs.

For higher resolving power and readings to mass 150

TYPE 21-620 has the highest mass range of any instrument in its compact size range. Using the new "Cycloidal Focusing" principle, it goes beyond the 21-610 for accurate readings from mass 2 to mass 150. Medical laboratories, petrochemical plants and general research organizations will all find it ideal for their analytical problems.

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For more information circle **101** on inquiry card.

NEW INSTRUMENTS

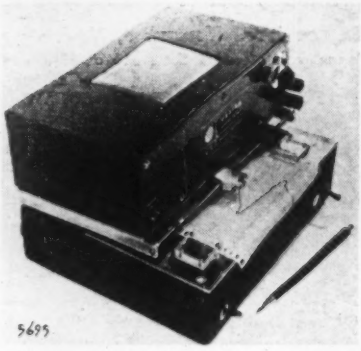
only slightly larger than a shoe box and weighs 19 lb. Example of versatility: It can be used to measure time intervals as long as 2.5 sec and as short as risetime of its signal amplifier which is 0.08 usec. It also is an ac-dc electronic voltmeter with a range of 0.4 to 400 v full scale, with an upper frequency limit of 4 Mc (30% down). It incorporates refinements usually found only in much higher-cost bench-type instruments.—*Allen B. Du Mont Labs., Clifton, N. J.*

For more information circle **398** on inquiry card.

ELECTRICAL INSTRUMENTS

Recording Potentiometer

New low-cost "Model G-10" can be used directly as a recording millivoltmeter or, with appropriate pickups, as

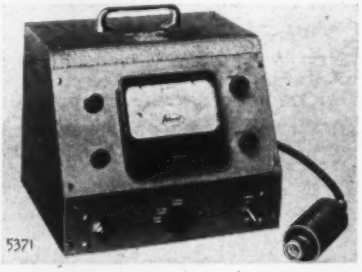


a means for recording pressure, temperature, etc.; is self-balancing potentiometer; standard full-scale response time 2.5 sec; standard sensitivity 100 mv full-scale; accuracy 1%; maximum allowable signal source resistance 0.5 megohm.—*Special Products Div., Varian Associates, 611 Hansen Way, Palo Alto, Calif.*

For more information circle **399** on inquiry card.

Power Meter

New "Model P-2" operates over frequency spectrum of dc to 11,000 Mc, has three ranges: 0-1, 0-10, and 0-100



mw. Accuracy of power readings can be quickly checked by means of a self-contained dc calibration circuit. New "P-2" measures cw and pulse power in milliwatts and db with better than 1-db accuracy over entire band; is insensitive to line voltage changes or frequencies.—*Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.*

For more information circle **400** on inquiry card.

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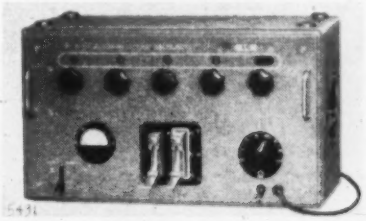
For more information circle **102** on inquiry card.

Wide-range Ohmmeter

New "Type RGV Resistance Precision Meter" features unusually wide range of 0.01 ohm to 100,000,000 ohms



and extraordinary accuracy: 0.1% ±1 milliohm in ranges to 10 megohms, 0.5% from 10 to 100 megohms; digital readout and automatic decimal place indication; complete protection against overload; low power (less than 10 mw) applied to sample.—*Instrument Div., Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J.*

For more information circle **401** on inquiry card.

Measurement System

New "Model EKA-1D Control System," for operation of pickups and data transmitters, comprises oscilla-

tor-power supply, bridge control system, carrier amplifier, demodulator and panel readout system. Feature: stability of 0.25% with line fluctuations between 95 and 140 volts. Readings can be indicated on a deflection-type instrument, or recorded remotely, or read out on a 1,000-division panel dial. System can be set for carrier frequencies between 400 cps and 25 kc.—*Crescent Engineering & Research Co., 11632 McBean St., El Monte, Calif.*

For more information circle **402** on inquiry card.

Digital Ratiometer

New "Model 625" rapidly displays a three-digit indication of ratio (from 000 to 1.000) between two related direct voltages, accurate to 5 parts in 1000. Average reading takes 1 to 2 seconds; internal balancing process is continuous; thus inputs can vary slowly. Four input channels are available through a selector switch; their resist-

5551

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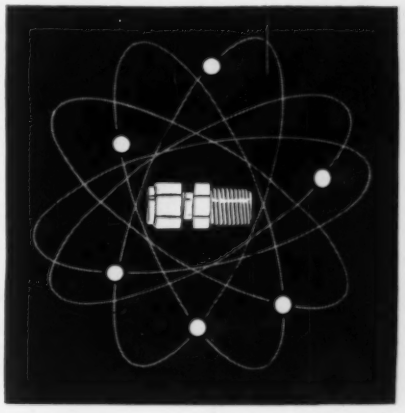

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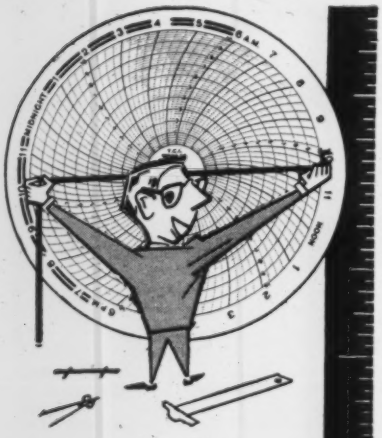

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For more information circle **104** on inquiry card.

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For more information circle **105** on inquiry card.

NEW INSTRUMENTS

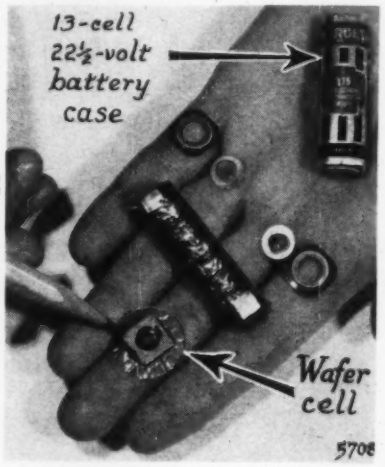
ance can be read up to 10,000 ohms. Instrument uses basic principle of self-balancing bridge, operates on a nominal bridge voltage of 5 v. Loading of test circuit is less than 0.01 ma under worst condition and zero when bridge is balanced. Maximum external current when measuring resistance values is 0.54 ma.—*Hycon Mfg. Co., 365 So. Arroyo Pkway, Pasadena, Calif.*

For more information circle **403** on inquiry card.

ELECTR-INSTRUMENT ACCESSORIES

High Power/volume Ratio Instrument Cell

New "wafer cell," said to make possible a 30% increase in battery power and life, consists of a sandwich of artificial manganese dioxide mix



between tiny discs of flat zinc and carbon electrodes. Sandwich is swiftly machine-wrapped in an airtight pliofilm envelope and heat sealed. Welded or soldered wire connections between cells are eliminated by use of silver wax (developed by maker's engineers) which permits cells to be connected in series by being stacked and which maintains 100% inter-cell connections under rugged handling. Photo shows "Y15" 2-in-long battery of 13 cells in a single column. Among others is "U200" battery which develops over 300 v in less than 20 cu in of space. Thanks to sandwich design, production-line machines (designed and built in company's own shops) are fed raw materials automatically from rolls or sheets, and turn out finished cells automatically.—*Burgess Battery Co., Freeport, Ill.*

For more information circle **404** on inquiry card.

Instrument Transformer

New "Type JCP-0," said to be "the first 600-volt indoor-outdoor instrument transformer with a 1200-4000 amperage rating," is a butyl-molded window-type unit suitable for instruments, meters, relays or control devices; is rated for 25- to 60-cps service; is designed for high accuracy; is

suitable for use over bare conductors on circuits not exceeding 600 v line-to-line and can be used with insulated conductors on higher voltage circuits. Allowable temperature rise 55C° above 30°C ambient. Silicon steel core is wound in a continuous strip to take full advantage of low core losses and high permeability; then annealed after winding for stress relief.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **405** on inquiry card.

Instrument Transformer

New "Type SM-5" 5-kv current transformer, molded in silicone, is designed for indoor metering and relaying applications; is built in standard current ratings from 10 to 800 amp; has a rating factor of 1.5; is in 0.3 accuracy class for all metering burdens; meets all ASA and NEMA standards; weighs 18 lb; can be mounted in any position on wall, column, ceiling, or floor. Primary terminals are silver-plated.—*Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.*

For more information circle **406** on inquiry card.

Outdoor Transformers

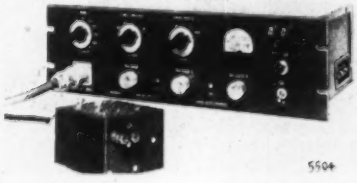
New "Type EMR" and "Type EMO" polyester-molded outdoor current transformers, designed for 600-v service, have 0.3 accuracy with B-0.1 and B-0.2 burdens; have a rating factor of 2. "EMR," having a round primary opening, is supplied in 200/5- and 400/5- amp ratings; "EMO," with an "obround" opening, is supplied in 200/5-, 400/5-, 600/5- and 800/5-amp ratings.—*Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.*

For more information circle **407** on inquiry card.

AMPLIFIERS

Measurement Amplifier

New dc amplifier combining high gain, low noise and drift, and wide band-pass is suitable for geophysics, biological research, etc., requiring



work at extremely low signal levels; features push-pull input and output circuits with input impedance of 100 megohms and grid current of 10^{-8} amp or less; band-pass flat to 50 kc minimum and usable to 100 kc; front-panel selectable band-widths (down ½ at upper limit) of dc to 100 cps, 400 cps, 1 kc and 4 kc. Sensitivity can be varied by a calibrated attenuator with maximum gain of 100,000.—*Am. Electronic Lab., Inc., 641 Arch St., Philadelphia 6, Pa.*

For more information circle **408** on inquiry card.

I-F Amplifiers

Three new subminiature I-F amplifiers used in airborne radar systems and broadband receivers are said to

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PANALARM "50" ANNUNCIATOR SYSTEMS

PANALARM "50" PLUG-IN UNIT . . . hermetically sealed and most versatile ever developed . . . simply plugs into chassis to expand system . . . no wiring . . . no other connections. Corrosion-proof and suitable for Class I, Div. 2 locations.

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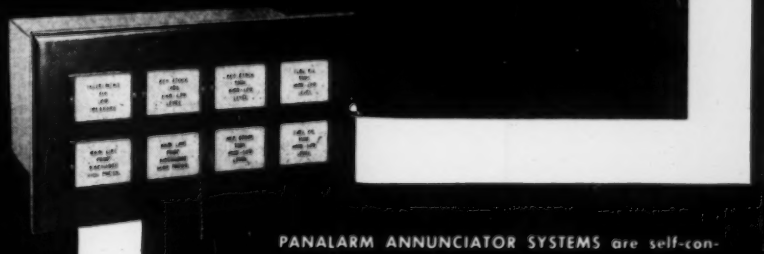

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EAGLE

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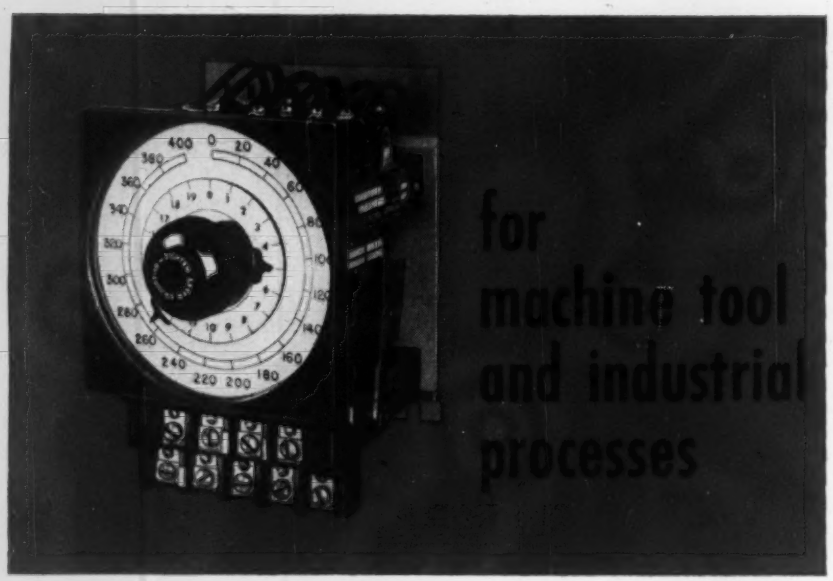

makes shutdown and feed-down automatic

Convert machine tool and industrial processes from manual to automatic operation — with this Microflex Reset Counter. For example, use it to feed a grinding wheel down after a preset number of operations. Or employ it to shut down a machine at the desired number of operations. This reset counter is ideal for controlling chemical feeding processes by shutting down a pump after the desired number of operations.

The Microflex Reset Counter is actuated by a series of electrical impulses. Models are available with 400 and 1000 count dials. Dial settings easy to make — counting range from 1 to 400 in steps of 1 with 100% accuracy. On 1000 count range, dial settings are in steps of 1 with accuracy of ± 1 count. Spring reset in less than 1 second.

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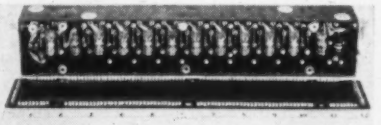
For more information circle **107** on inquiry card.

feature high gain and wide bandwidth and to "provide performance not obtainable in existing miniature equipment." Gains of over 100 db are ob-



tained simultaneously with bandwidths over 12 Mc at center frequencies of 30, 60, or 90 Mc ("Models M1154, M1155 and M1156" respectively). Construction provides complete shielding and absence of regeneration even with covers removed. Tubes have rated life of over 5,000 hours.—*Maxson Instruments*, 47-37 *Austell Place, Long Island City* 1, *N. Y.*

For more information circle **409** on inquiry card.

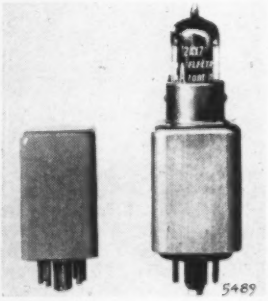
Magnetic Amplifier

New "Part No. T1616JC" six-watt 115-v 400-cps magnetic amplifier is designed specifically for instrument type airborne servo systems; operates directly from a synchro control transformer or VDR without preamplifier or demodulator. Unit's 3-stage fast-response half-wave bridge circuit is capable of a 20-cps bandwidth when driving a BuOrd Servo Motor Mk 7 in a closed-loop system using simple circuitry.—*Specialties, Inc., Skunks Misery Rd., Syosset, L. I., N. Y.*

For more information circle **410** on inquiry card.

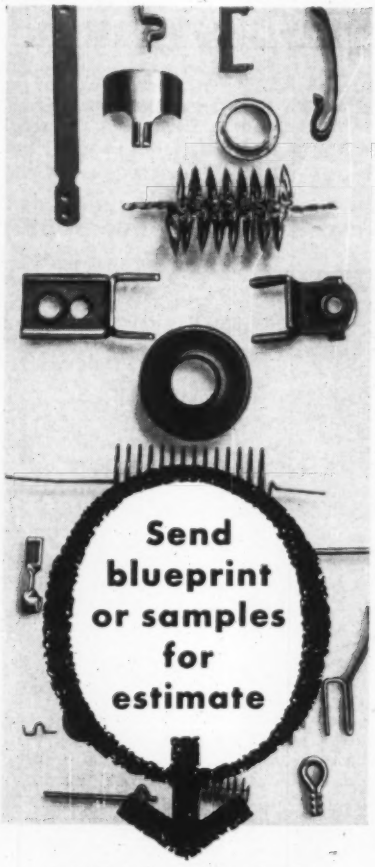
L-f Band-pass Amplifier

New "Models 211 and 212" amplifiers, when used with matching twin-T feedback networks, become size- and



weight-saving filters or band-pass amplifiers in 5-to-500 cps range. Amplifier and feedback network are separate plug-in units, all interchangeable. One-tube "Model 211" has a voltage gain of 15 and a *Q* of 8, when used with a "Type 552" network. Two-tube "Model 212" has a gain of 80 and a maximum *Q* of 40 with "Type 542" network.—*White Instrument Laboratories*, 203 *E. Riverside Drive, Austin* 4, *Texas.*

For more information circle **411** on inquiry card.



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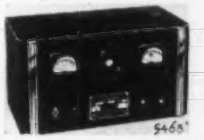
POWER SUPPLIES

D-c Power Supply



New low-cost 0-28-vdc 10-amp power supply operates from 115-v 60-cps ac; is one of maker's 22 standard economy models. — *Opad Electric Co., 69 Murray St., New York 7, N. Y.*

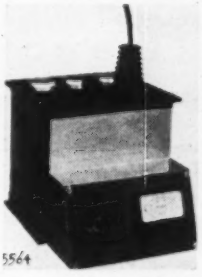
For more information circle **412** on inquiry card.

Power Rectifiers

New "Stavolt D-C Rectifiers" feature improved circuitry making possible 0.5% voltage regulation accuracy, 1% d-c ripple, and 0.1-sec recovery time, without increase in size, weight or cost. Eleven standard 28-v production models with capacities up to 1500 amp, mobile or stationary types.—*McColpin-Christie Corp., 3410 W. 67th St., Los Angeles 43, Calif.*

For more information circle **413** on inquiry card.

High-voltage Supplies



Two new series of 60-, 100- and 200-kv power supplies are available in six unusually compact models. Input is 115 vac; max. continuous current output is 1 ma. Positive or negative polarity. Exceptional safety guards. A suitable variable-transformer permits ac primary voltage of hv transformer to be varied independently of filament voltage.—*Microtime Laboratories, 7247 Atoll Ave., N. Hollywood, Calif.*

For more information circle **414** on inquiry card.

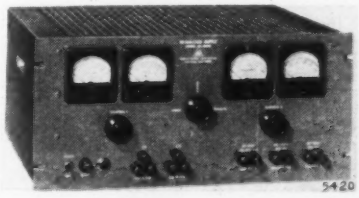
High-voltage Supplies

New line of mass-produced industrial high-voltage supplies includes 23 standard sizes available from stock, all with "Basic 20" safety and convenience features which include: reversible polarity, adjustable over-current and over-voltage trip-outs, multi-range grounded voltmeter and milliameter hand-calibrated to 2% at factory.—*NJE Corporation, 345 Carnegie Ave., Kenilworth, N. J.*

For more information circle **415** on inquiry card.

Dual Power Supply

New "Model D5-200C" has switching arrangement that combines dc outputs in series or in parallel, thus doubling voltage or current. Eight outputs: two for 30-500 vdc @ 200 ma; two for 6.3 vac @ 10 amps, one for dc series connection; one for dc



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Reliable Statham unbonded strain gage transduction

Precisely calibrated with high accuracy potentiometers

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20 millivolts at 5 volts excitation

Temperature compensation over 315°F. interval

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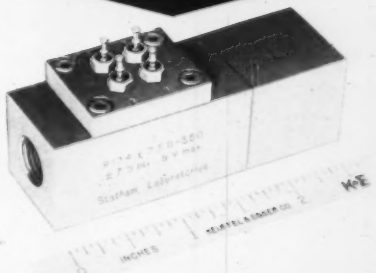


Model P134 Pressure Transducers for the measurement of differential pressures are described fully in

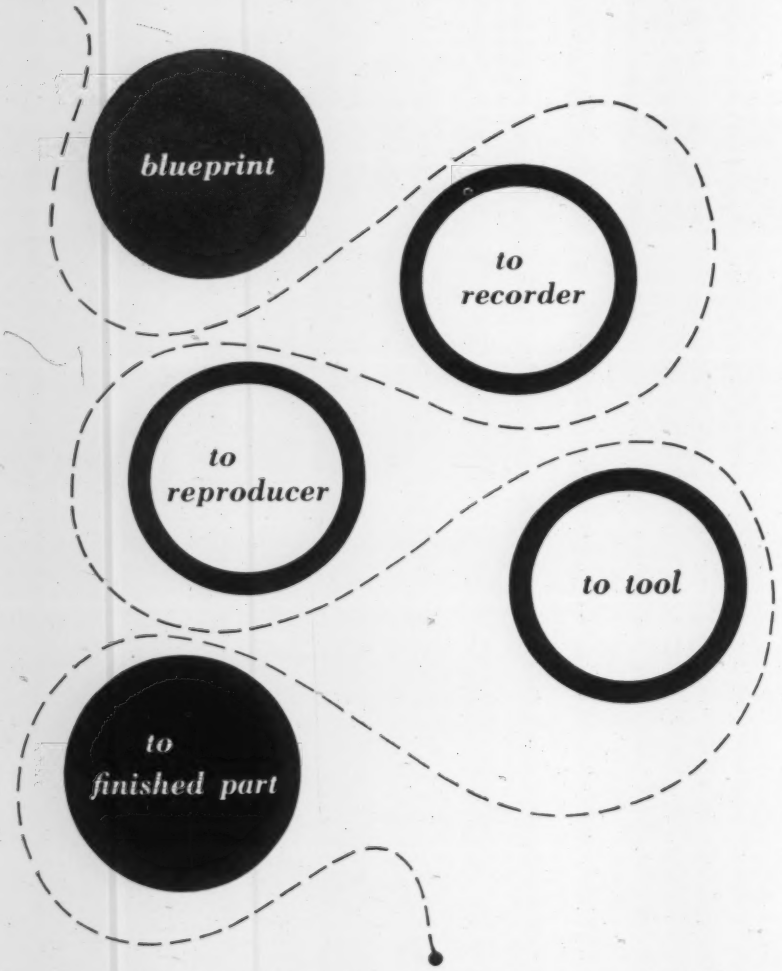
Bulletin MPT-134 available upon request.

Statham

LABORATORIES

12401 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle **109** on inquiry card.



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For more information circle **110** on inquiry card.

parallel connection; one each for ac series and parallel connection.—*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.*

For more information circle **416** on inquiry card.

Transistorized Power Supply

New power supply unit, encapsulated and fully transistorized, was originally designed for use in maker's own Geiger counters; unit is adaptable for use with many other instruments. It will supply filtered direct voltages of over 5000 from one 1½-v flashlight battery.—*Universal Atomics Inc., 19 E. 48th St., New York 17, N. Y.*

For more information circle **417** on inquiry card.

Transistor Power Supply

New "Model C-22" regulated dc power supply, designed especially for use in transistor work, has a range of 0-50 v, 0-1 amp; has internal reference (using a 2-stage amplifier) for an internally regulated power supply and a Type 5651 tube for a stable reference. Regulation is 0.1% and ripple is less than 1 mv. 4½-in voltmeter on 7 x 19 in panel.—*Universal Electronics Co., 1720 22nd St., Santa Monica, Calif.*

For more information circle **418** on inquiry card.

Regulated Power Supply

New "Model 702A" features maker's unique chassis construction said to provide "the most efficient utilization of space with no sacrifice in accessibility of components." Output voltages from 0 to 600 continuously variable; currents up to 200 ma; regulation 0.25% or better; also 0-150 v variable negative output for bias and 6.3 v. at 8 amps.—*Shasta Div., Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.*

For more information circle **419** on inquiry card.

Sub-chassis-type Dc Supply

New "Model .28-2MX," designed for operating control equipment on unregulated 28 vdc, is built for continuous duty in lab or production testing, and in original equipment; employs a selenium rectifier; has sufficient filtering to operate relays, solenoids, motors, etc. Input 115 v 60 cps; output 28 vdc, 2 amp; ripple 2.2 v maximum. Weight 6 lb.—*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena 8, Calif.*

For more information circle **420** on inquiry card.

ELECTRICAL COMPONENTS

Germanium Diodes

New types of gold-bonded germanium diodes designed to standard RETMA specs feature average for-

ward conductance and inverse resistance "materially greater than that of the conventional point-contact diodes." Example: "T9" forward current over 100 ma at 1 v with 5 megohms inverse resistance at –10 v; peak operating currents of over 300 ma. Other diodes such as "T5" have inverse resistances greater than 1 megohm at –100 v.—*Transistron Electronic Corp., Melrose 76, Mass.*

For more information circle **421** on inquiry card.

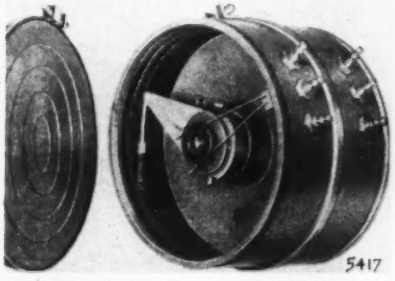
Combination VDR-VT

New 400-cps "Vernistat," for use in servo systems and analog computers, combines features of a voltage-dividing resistor and of a variable transformer; has a low output impedance (less than 130 ohms) and an extremely low phase shift. Size and mounting dimensions have been designed to BuOrd specs for a size 18 synchro. Weight 10 oz. High linearity (0.05% standard) makes it a precision voltage divider, as well as a reference voltage generator or follow-up unit in servo systems. In analog computers it multiplies a shaft angle by a voltage.—*The Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **422** on inquiry card.

3-in. Ganging VDRs

New "Model 300" fully-enclosed 3-in ganging voltage-dividing resistors are economically priced for applica-



tions that do not require high-precision types; are independent-phasing; have 8-watt power rating.—*DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City, N. Y.*

For more information circle **423** on inquiry card.

Small Ganged VDRs

New ganged assemblies of "#500 Acepots," subminiature wire-wound precision voltage-dividing resistors, are said to "have the accuracy required by many computer and servo

Self-scouring!

SIMPLEX PARABOLIC FLUME

Measures open flows within ± 2%

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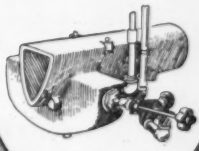

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Easy to Install! No special approach piping needed. Inlets fit 6" to 36" pipe. Levelling pins simplify field setting.

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For more information circle **111** on inquiry card.

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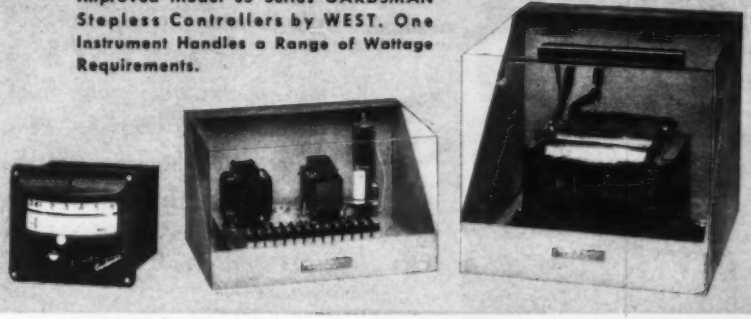

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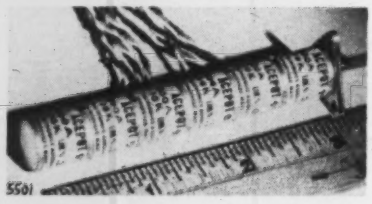
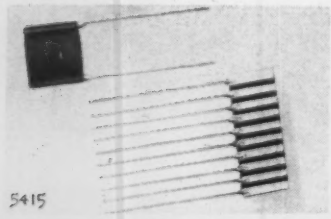


control applications" and their extremely small size saves space and weight in equipment. Available in resistance range from 200 to 100,000 ohms. Standard accuracy of linear units is 0.3% independent linearity. Standard torque 0.035 oz-in @ 20° C (even lower on special order).—*Ace Electronics Associates*, 125 *Rogers Ave., Somerville* 44, *Mass.*

For more information circle **424** on inquiry card.

Card-type Resistors

New "Series 1300" single-section card-type resistors are wafer-thin, are completely encapsulated for protection against humidity, salt-water immersion and temperature extremes; are especially adaptable for circuits using transistors.—*The Daven Electronic Sales Corp.*, 191 *Central Ave., Newark* 4, *N. J.*



For more information circle **425** on inquiry card.

Replacement Transformers

New exact-replacement horizontal and high-voltage output transformers have been added to maker's line: "HVO-38" and "HVO-54" for Admiral, "HVO-40" for Silvertone, "HVO-37" for Silvertone, Sentinel, Hallicrafters and the Crosley "Super V"; also several others.—*Merit Coil & Transformer Corp.*, 4427 *N. Clark St., Chicago* 40, *Ill.*

For more information circle **426** on inquiry card.

Control Transformers

New control transformers feature use of new materials, including Alkanex wire, and a unique method of frame size design, as major factors in weight and size reduction up to 40%. Within each frame size (related to va capacity) a wide variety of voltage combinations is available, with no change in over-all and mounting dimensions. Eleven available transformer frame sizes include most popular ratings.—*Specialty Transformer Dept, General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **427** on inquiry card.

Cartridge Rectifiers

New "Type 60-6979" selenium cartridge rectifier has been especially designed for use in strobe flash units and similar instruments requiring high transient peak currents for capacitor charging; is a single-phase full-wave bridge type delivering 9.6 ma average current and 190 ma peak pulse current at 495 vdc capacitive load. Length 3⅛ in; OD ⅜ in; radial pigtail leads; 6-32 threaded brass inserts at both ends for easy mounting; fungus- and moisture-resistant protective finish.—*International Rectifier Corp.*, 1521 *S. Grand Ave., El Segundo, Calif.*

For more information circle **428** on inquiry card.

Radio Noise Filter

New subminiature light-weight dual-pi noise filter for actuator motors is rated at 2 amp 200 vdc; brings noise level far below Mil-I-6181 requirements throughout frequency spectrum. Epoxy resin dielectric permits efficient operation at 300°F.—*Electronic Specialty Co.*, 5121 *San Fernando Rd., Los Angeles* 39, *Calif.*

For more information circle **429** on inquiry card.

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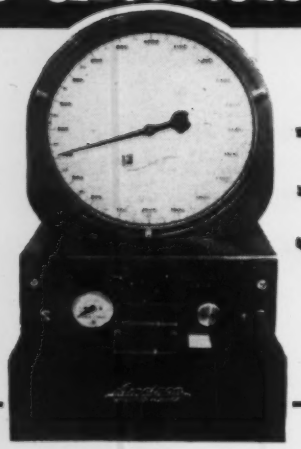

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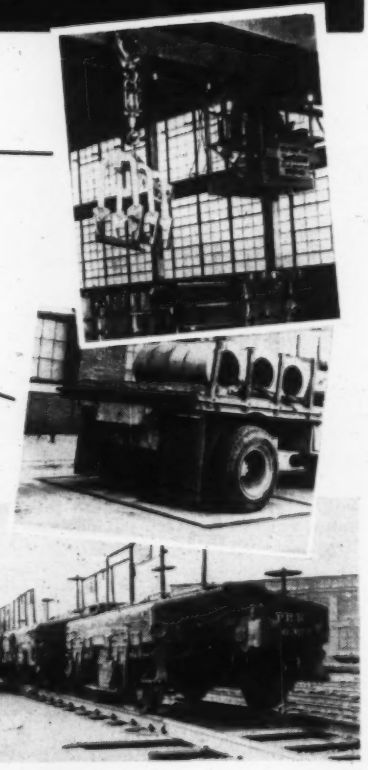

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For more information circle **113** on inquiry card.

Tubular Capacitors

New "Electrica" molded plastic tubular metallized paper capacitors are said to offer impervious immersion-proof shell minimum size, light weight and low prices; function at temperatures from –20°C to 110°C.—*Arnhold Ceramics, Inc., 1 E. 57th St., New York 22, N. Y.*

For more information circle **430** on inquiry card.

Ceramic Capacitors

New small-size high-capacity "Ceramicons" are rectangular, have a phenolic dipped coating, wax-impregnated #22 hot-tinned copper leads, and are made in three sizes: 0.34 x 0.34 in, 0.58 x 0.43 in, 0.75 x 0.56 in. Life test, 400 vdc 1000 hours at 85°C; flash test 600 volts dc; power factor 2.5% max. at 1 v rms 1 kc. Value range from 0.0022 to 0.1 mfd; 200-v rating.—*Erie Resistor Corp., 644 W. 12th St., Erie, Pa.*

For more information circle **431** on inquiry card.

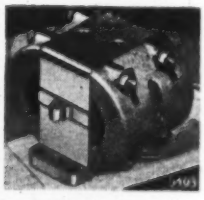
High-temperature Tantalytic Capacitors

Two new lines of 125° C tantalytic capacitors, as stable and as lasting as standard 85° C tantalytics, comprise: (1) rectangular case types, ratings from 36 uf at 100 vdc to 220 uf at 25 v; (2) cylindrical case types, from 36 uf at 100 v to 160 uf at 10 v. New units will perform for 1,000 hours at 125° C without losing more than 20% of 25° C capacitance.—*Capacitor Dep't, General Electric Co., Hudson Falls, N. Y.*

For more information circle **432** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Torque Motor



New "Model 21" is designed to drive hydraulic servovalves or other mechanisms which demand fast response and high output force proportional to input current. It weighs 18 oz but is conservatively rated at 9 lb force for 40 ma differential current. It can be driven from two miniature output tubes in push pull, or from magnetic amplifiers. Stroke (±0.015 in) is proportional to input differential current; displacement sensitivity is 0.75 in per ampere, or 20 ma for full stroke.—*Raymond Atchley, Inc., 2340 Sawtelle Blvd., Los Angeles 64, Calif.*

For more information circle **433** on inquiry card.

Thumb-sized Motor for Aircraft Applications

New motor for a wide variety of aircraft applications was originally designed for maker's compass-controlled directional gyro-compass system; is believed to be "the smallest motor currently used on aircraft." Diam ⅝ in; length 1.2 in; weight 1.2 oz; rating 26 v 2-phase; no-load

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AKRA-OHM Precision Wirewounds

Bulletin L-35

High-quality, yet moderately-priced precision resistors suitable for the majority of applications. Reverse-pi wound on accurately-machined ceramic bobbins. Coated, if desired, with moisture-resistant varnish. Std. tolerance—1%, 0.5%, 0.25%, 0.1%, and 0.05%. Meets MIL-R-93A. Five mounting styles available.

"P" TYPE Encapsulated Wirewounds

Bulletin L-30

Small, hermetically-sealed resistors at a truly low price. Unmatched stability for critical applications. Std. tolerance—same as Akra-Ohm types above. Meet and exceed MIL-R-93A requirements including salt water immersion tests. Radial leads, axial leads, or lug type terminals.

DEPOSITED CARBON Precision Resistors

Bulletin L-33

These small carbon-film resistors achieve exceptional stability through deposition of a uniform, uncontaminated film of carbon on a ceramic core. Temperature coefficient: 500 ppm per °C above 1 meg., 300 ppm per °C below 1 meg. Std. tolerance—1%, 2%, and 5%. Meet characteristic R of MIL-R-10509A. ½, 1, and 2 watt sizes.

CASTOHM Ceramic Power Resistors

Bulletin L-29

Unusually light-weight wirewound power resistors with a unique integral core and coating having exceptional resistance to thermal shock and excellent heat conductivity. Ten humidity-resistant, tab-terminal styles available with ratings from 8 to 225 watts at 350°C. hot-spot. Meet MIL-R-10566, Amendment 1.

CMP and **MP** Miniature Power Wirewounds

Bulletin L-36

Lead-mounting, miniature power wirewounds for crowded chassis or printed circuits. MP types enclosed in a Fiberglas sleeve and coated with silicone-impregnated ceramic. CMP types encased in ceramic tube with ends hermetically sealed with silicone cement. Designed to MIL-R-26B. 3 to 10 watt sizes available.

SPECIALS . . . . . .

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Hermetically-sealed Steatite resistors, Ayrton-Perry resistors, high-voltage surge resistors, card-type resistors, multi-section bobbin resistors, and many other special types are regularly produced to individual specifications.

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For more information circle **114** on inquiry card.

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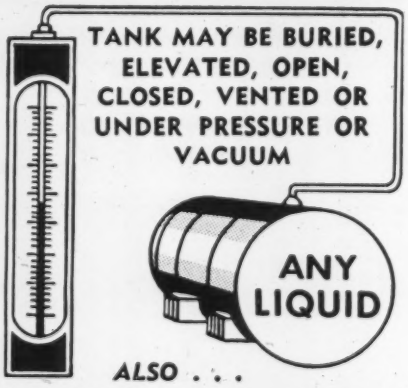

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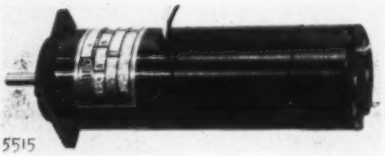
For more information circle **117** on inquiry card.

speed 21,000 rpm; ambient temperature range –55° C to 90° C when operated as a control motor.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **434** on inquiry card.

Servomotor Package

New "Model #5012-166" package consists of (a) maker's Standard Series 5000 1¼-in diam 115-vdc PM motor; (b) clutch-brake mechanism; (c) clutch-brake actuating housing; (d)



gear train. When power is applied, clutch instantly engages gear train to motor unit as motor accelerates. Conversely, when power is interrupted, clutch-brake coil is de-energized simultaneously with motor; braking mechanism instantly stopping input shaft to gear train. Another feature is that clutch imposes practically no load on motor.—*Burton Mfg. Co., 11201 W. Pico Blvd., Los Angeles 64, Calif.*

For more information circle **435** on inquiry card.

H-f Motor-Alternators

Three new high-frequency motor-alternators convert from nominal 400-cps 3-phase 208-v line to single-phase power at 1150, 2350, or 4700 cps respectively. All are characterized by good regulation with low internal reactance, low harmonic content, and complete absence of sliding contacts in electric circuit. All are suited for laboratory and field use. Weight 5¾ lbs; over-all length, 5½ in; diameter, 3⅛ in.—*D&R, Ltd., 402 East Gutierrez St., Santa Barbara, Calif.*

For more information circle **436** on inquiry card.

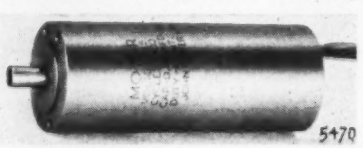
Size 10 Synchro

New "Type 3G" miniature (Size 10) synchro weighs 1¾ oz; has unusually high permeability; is exceptionally resistant to corrosion, owing to the use of a high nickel alloy for laminations. Spread of angular error is from 20 to 30 minutes. Length 1.278 in; OD 15/16 in. Designed for use in 26-v 400-cps systems.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **437** on inquiry card.

Subminiature M-g

New "Type MG 3013" is said to be "the smallest motor generator available." OD 1 in; length 2⅝ in; weight



6.2 oz. Unusually high output: 1.25 volts per 100 rpm when operated into a load of 100,000 ohms. Speed continuously variable from 200 to 8700 rpm. Output remains linear over entire

speed range. Harmonic distortion is under 5%. Magnetic detent stops output shaft in any of 4 positions within 5° accuracy.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **433** on inquiry card.

Subminiature Relay

New sensitive subminiature dpdt relay is sealed and nitrogen-filled; diam 0.656 in; length 1.500 in; weight 1 oz; available in contact ratings to 5 amp resistive (10 amp special) at 28 vdc or 115 vac; meets MIL-R-5757B and MIL-R-6106A; functions over ambient range of –65° C to 125° C; withstands 10-*G* vibration at 10-500 cps, and 50-*G* shock.—*Electro-Mechanical Specialties, Inc., 6819 Melrose Ave., Los Angeles 38, Calif.*

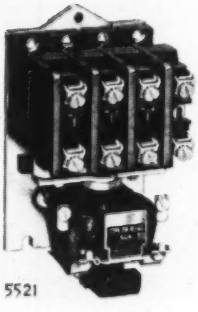
For more information circle **439** on inquiry card.

"Taper-pin" Relays

New vibration-resistant relays are hermetically sealed with "taper-pin" terminals for solderless connection, are available in 2-, 3- and 4-pole models; surpass MIL-R-5757B and MIL-R-6106A.—*Electromechanical Specialties Co., Inc., 6819 Melrose Ave., Los Angeles 38, Calif.*

For more information circle **440** on inquiry card.

Heavy-duty Relays



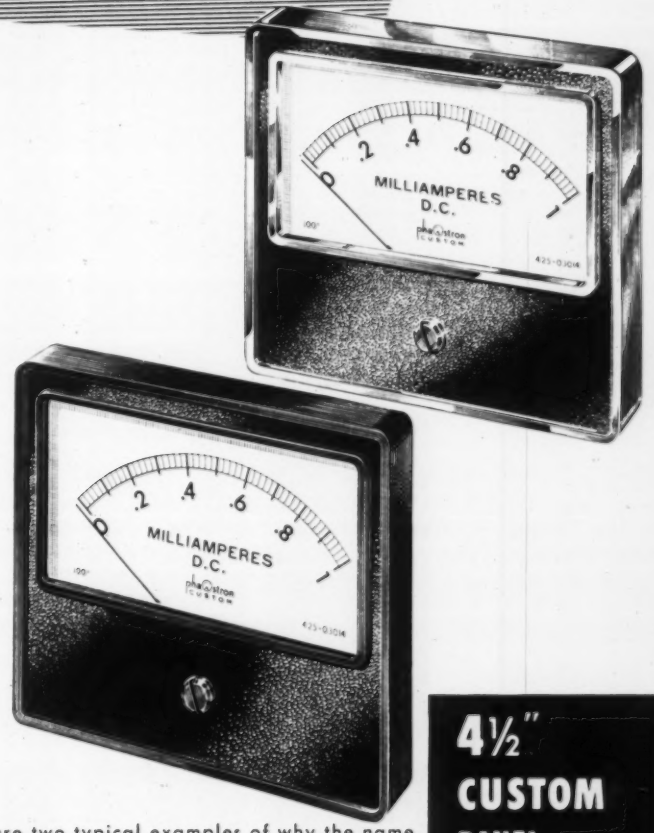
New "Type PM" 10-amp control relays occupy minimal panel space without sacrifice of ruggedness; are said to provide increase in ease of wiring and maintenance; are available with from two to twelve poles; feature unique sectional pole design; each pole mounted on its own melamine block, each removable and replaceable without disturbing other poles or other wiring. Poles can readily be converted from N-O to N-C, or reverse, in the field.—*Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.*

For more information circle **441** on inquiry card.

Graphic-circuit Relay

New "Series SQD Printed Circuit Relay" features new design which permits direct insertion of its terminals into circuit board, ready for immediate soldering because these terminals, instead of being brazed or

PHAOSTRON
NONE FINER



4½" CUSTOM PANEL INSTRUMENTS

Pictured here are two typical examples of why the name Phaostron is so rapidly gaining enthusiastic acceptance wherever and whenever truly fine Panel Meters are admired, required and specified.

They are the latest additions to the Phaostron line of "Custom" Panel Instruments which include 2½", 3½" and 6" sizes.

Built to the exacting standards of excellence that identify every Phaostron product.

BUILT TO HIGHEST QUALITY . . . SOLD UNBELIEVABLY LOW

Metal Case . . . won't chip, shatter or warp.

Large Clear Scales . . . Increments and numerals can be read at a distance of 10 feet.

Permanent Accuracy . . . plastic cased meters often vary up to 35% . . . these metal cased meters . . . never.

Anti Magnetic . . . shielded by their metal case from stray magnetic fields.

Insulated Zero Adjustments . . . large, easy-to-use . . . safer.

Two Models:

"Custom" Chrome: Die cast bezel is finished in gleaming polished chrome and black.

"Custom": This instrument is identical, but is finished in solid color.

Both are available with self-contained 5,000 hour lamps where illuminated scales are desirable.

SEE YOUR PARTS JOBBER OR WRITE DIRECT

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PHAOSTRON COMPANY
151 PASADENA AVE. • SOUTH PASADENA, CALIF.

For more information circle **118** on inquiry card.

ELECTRONICS

easy to teach
...easy to learn

with the New, Low Cost

Crow Basic Electronics Kit Model 50-A

for INDUSTRIAL TRAINING or HOME STUDY

• Here's the ideal instruction aid for your employee training program—a combination of equipment and text material designed to let you learn electronics by *visual experiment.*

The kit contains 82 precision components, everything you need to perform 60 experiments. A correlated, 275-page work manual shows you in words and pictures exactly how to proceed.

Model 50-A complements Crow Electri-Kit Model 41-B . . . takes you from Beginners' Electricity directly into the study of Electronics. With this unique kit, anyone familiar with basic electrical principles can learn electronics easily. It can even be used for self instruction at home . . . as fascinating as your favorite hobby.

60 OPERATING ASSEMBLIES

Capacitors • Voltage Dividers • Vibrators
Frequency Discriminators and Multipliers
Filters • Electrical Indicating Instruments
Rectifiers • Resonant Circuits • many more

Price of the complete, 82-piece Model 50-A kit—including precision meter (±1%), resistors, coils, capacitor bank, etc.—is $87.50. Write for illustrated folder giving full details.

Model 50-A Kit provides a solid foundation for further training in specialized electronic fields—Radio Transmitting and Receiving, Industrial Electronic Circuitry, or Radar and Television Circuitry.

These principles are covered in the Crow Electronic Tubes, Circuits and Devices Kit (Model 53) available soon.

CROW ELECTRI-CRAFT CORP.

Division of Universal Scientific Co., Inc.
Box 336W, Vincennes, Indiana

For more information circle **119** on inquiry card.

NORTHAM

HIGH RANGE PRESSURE TRANSDUCER

Length 2½" Weight 12 oz.

A variable inductance instrument for the measurement of steady state and transient pressures in rocket and engine testing, hydraulics research, and other applications involving high pressure measurement and control. The pressure sensing diaphragm is integral with the body, providing high resistance to shock and vibration. There are no other moving elements. May be worked with non-corrosive liquids and gases.

MODEL GP-8 SPECIFICATIONS:

Pressure Ranges: . . . . . 0-200 to 0-5,000 psig
Maximum Allowable Pressure: . . . Twice rated pressure range
Accuracy: . . . . . ± 1% full scale
Excitation Frequency: From 60 to 20,000 cps
Natural Frequency: From 2,000 cps to 10,000 cps depending on range
Acceleration Response: Less than 1%/1,000 g along most sensitive axis (range above 1,000 psi)
Less than 1%/1,000 g axial (all ranges)

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Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE . . .
Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

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2420 North Lake Avenue • Altadena, Calif.

For more information circle **120** on inquiry card.

Over 85% of the torque wrenches used in industry are

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TORQUE WRENCHES

Read by Sight, Sound or Feel.

- Permanently Accurate
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- Faster—Easier to use
- Automatic Release
- All Capacities

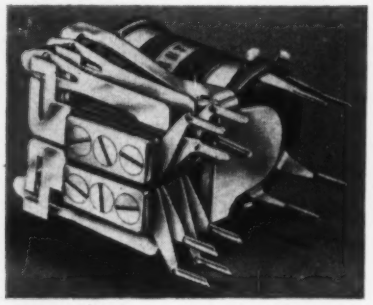
in inch grams...inch ounces,..inch pounds ...foot pounds (All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

P. A. STURTEVANT CO.
BOSTON (QUALITY) ILLINOIS

For more information circle **121** on inquiry card.

NEW INSTRUMENTS

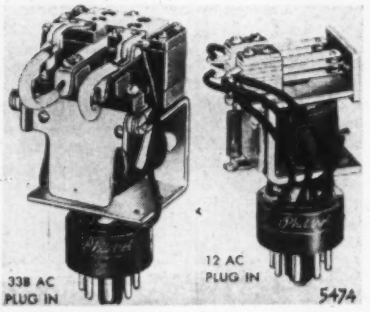


welded together in sections, have been made integral parts of coil terminals and contact springs. Relay's two contact arms permit two spring pile-ups of up to 9 springs each.—*Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.*

For more information circle **442** on inquiry card.

Plug-in Relays

Two new plug-in models have been added to maker's line. (1) "Phil-trol 33B" general-purpose power relay

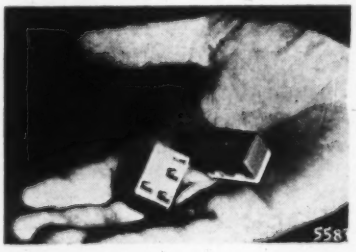


available in 2-, 3- or 5-pole ac or dc models; (2) smaller "Phil-trol 12" available for operation on up to 230 v ac or dc.—*Phillips Control Corp., Joliet, Illinois.*

For more information circle **443** on inquiry card.

Snap Switches

New "Klixon K Series Sine Switches" for aircraft and industrial controls, actuators, relays, instru-

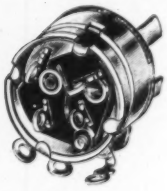


ments, etc., feature unique sine curved switching element for excellent performance under shock and vibration (withstand from 0 to 500 cps at 10 *G* while continuously loaded to within 0.0002 in of actuation point). Movement differential 0.0005 in. minimum; shock 200 *G;* temperature –65°F to 350°F; life 100,000 cycles minimum; rating 10 amp at 115 vac 1.0 pf or 30 vdc resistive.—*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **444** on inquiry card.

Volume-control Switch

New type of rotary switch uses unique "floating ring" contact action: make or break accomplished by

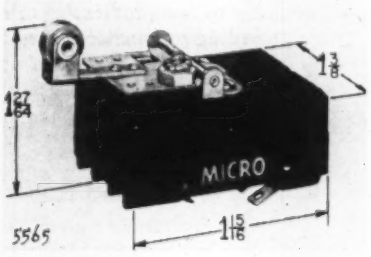


spring-snapped self-aligning motion of rings of maker's contact alloy; rings "float" on pins so that they can rotate slightly with each operation, whence a continually-changing contact surface.—*P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.*

For more information circle **445** on inquiry card.

Dual Switch

New "6AS13" single-actuated dual switch consists of two basic switching units operated by a single roller-lever



actuator. Operating point of one switching unit is field adjustable to provide either simultaneous actuation or a definite sequence of operation. Available with a variety of lever lengths, straight or formed levers, with or without a roller.—*Micro Switch, Freeport, Illinois.*

For more information circle **446** on inquiry card.

Acid-proof Switch

New acid-proof basic snap-action switch is available in N-O, N-C, or 3-wire types; is also immune to ex-

tremes of shock and vibration; meets Army spec 60-977-2 Class B. Electrical capacity 20 amp resistive, 28 vdc: 10 amp resistive, 110 vac.—*Control Products, Inc., Sussex St., Harrison, N. J.*

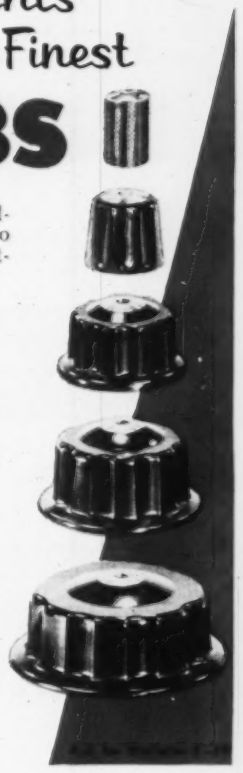
For more information circle **447** on inquiry card.

Nylon-insulated Connectors

Three new miniature nylon-insulated connectors, said to possess great durability and high voltage insulation properties, are each available in eleven colors for coding applications. Shockproof nylon insulating handles are unaffected by most chemicals and will withstand extremes of temperature and humidity. Tip and banana plugs (A and B) and

DALOHM® now presents America's Finest

Collet-fitting KNOBS



Dalohm design permits positive locking on all standard shaft diameters full round or flatted with no damaging effect so frequently found when using set-screw type knobs.

FIVE SIZES ⅜" 1 1/16" 1¾" 2¼" 3"

COLLETS INTERCHANGEABLE . . .
accommodate all shaft sizes from ⅛" to ⅜"

- Precision cast of thermo setting plastic in easy grip shapes. Pleasing appearance to match modern styling
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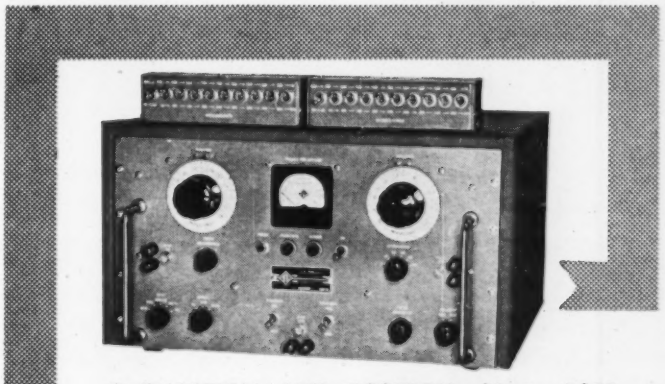
For more information circle **122** on inquiry card.

WIDE-RANGE FAST-PULSE GENERATOR

UNRETOUCHED PHOTO 0.25 μsec. Pulse

Model PG-200AA Pulse Generator • PGA-210 Range Extenders



- DURATION AND POSITION .05 to 1000 μs
- RISE AND DECAY TIMES CONSTANT .03 μs
- SINGLE PULSES TO 20,000 PER SECOND
- 100 VOLTS, 50 OHMS DRIVING IMPEDANCE
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TL TELETRONICS LABORATORY, INC. 54 KINKEL STREET WESTBURY, L. I., N. Y.

For more information circle **123** on inquiry card.

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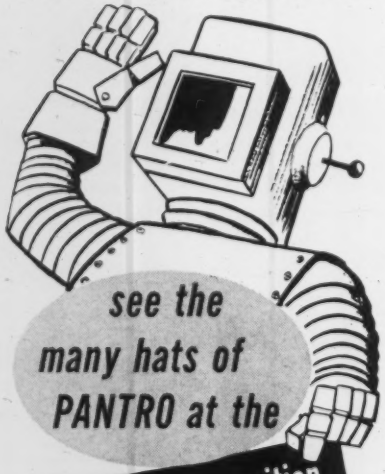
custom-made for any industrial use...O.E.M. and on-the-job installations

oil refining
food processing
machine tools
avionics
communications
printing presses
countless other applications



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For PANTRO data pertinent to your equipment, send description and specs. Write today.

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INDUSTRIAL CONTROL PANEL CO.
519 W. MONROE ST., CHICAGO 6, ILL.

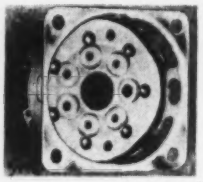
For more information circle **124** on inquiry card.

NEW INSTRUMENTS

tip jack and insulating sleeve assembly (C) are of simple functional design which "has made possible surprisingly low prices."—*E. F. Johnson Co., Waseca, Minn.*

For more information circle **448** on inquiry card.

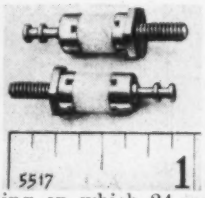
VHF Septar Socket



New 7-pin steatite-insulated tube socket, designed especially for new septar-based tubes, requires 1/3 in less chassis mounting space than previously available types. Integral ventilated aluminum shield base for optimal input and output shielding.—*Industrial Sales Dept., E. F. Johnson Co., Waseca, Minn.*

For more information circle **449** on inquiry card.

Teflon Terminals

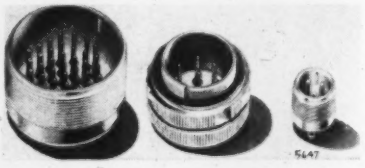


New "X-2168" Teflon-insulated terminal is said to have high dielectric strength and low capacitance. Solder terminal is brass with copper flashing on which 24-carat gold has been applied. Both stud and terminal are attached to Teflon by a unique method that makes terminal vibration-proof. —*Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.*

For more information circle **450** on inquiry card.

Extreme Heat and Pressure Connectors

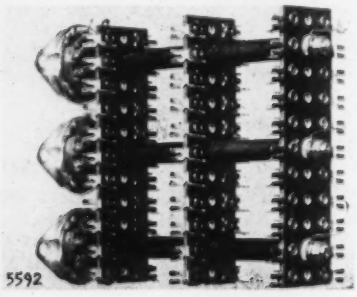
New "HS" 2 (AN 3102) receptacles and "HS 6" (AN 3106) plugs featuring "Vac Tite" glass-to-metal construction assuring leak-proof performance under conditions of extreme heat and pressure.—*Hermetic Seal Products Co., 33 South Sixth St., Newark 7, N. J.*



For more information circle **451** on inquiry card.

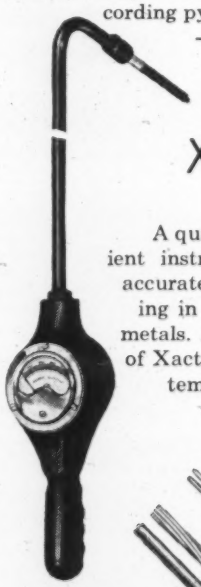
Deck Turret Sockets

New deck turret socket, featuring "zip" terminal that holds leads firmly until soldered, is of "fork" type with



PRECISION
TEMPERATURE
measurement and control

GORDON
XACTLINE
Controls temperature automatically within a fraction of a degree in any heat process. A complete factory-assembled unit ready for installation anywhere. Can be used with any existing indicating or recording pyrometer controller —regardless of age.



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XACTEMP
Hand Pyrometer
A quality-built, convenient instrument for quick, accurate temperature reading in molten nonferrous metals. Also, other models of Xactemp for all-around temperature checking.

GORDON
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Thermocouple Wire
Thermocouple Extension Wire
Insulated in Gordon's own plant to assure consistent quality.
All standard wire and insulations carried in stock for quick delivery. Other wires, in long or short runs, manufactured to specifications.

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For more information circle **125** on inquiry card.

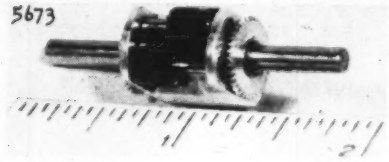
inner edges of fork serrated: when component-part leads are pushed into zip terminal, this serration holds part firmly for electrical and mechanical contact. This allows all components to be quickly assembled. Entire assembly can be dip-soldered with special component arrangements. Sizes from one to six tubes using any socket, available in XXXP phenolic, glass silicone or glass epoxy.—*Vector Electronic Co., 3352 San Fernando Road, Los Angeles 65, Calif.*

For more information circle **452** on inquiry card.

MECHANICAL COMPONENTS

Subminiature Mechanical Differential

New low-cost mechanical differential is believed to be "the smallest in existence." Over-all diam 19/32 in; input shaft diam ⅛ in; weight about



1/3 oz (10 grams) with typical end gears. Breakaway torque 0.01 oz-in (0.8 gm-cm). Subminiature ball bearings.—*Pitometer Log Corp., 237 Lafayette St., New York 12, N. Y.*

For more information circle **453** on inquiry card.

Mechanical Integrators

New 2½-in and 5-in "DBR" integrators, commercial models of units originally developed for gunfire con-

trol, utilize "DBR" (disc, balls and roller) design. Two hardened steel balls in a carriage between input disc and output roller minimize friction; ball roller tilt device minimizes ball slip for all carriage positions. Maximum force to move carriage is about ½ oz; maximum input torque at zero load is about ½ oz-in.—*Ford Instrument Co., 13-10 Thomson Ave., Long Island City 1, N. Y.*

For more information circle **454** on inquiry card.

Worms and Gears

New "Type Q" precision ground worms are immediately available in single, double and four threads, all right hand, in ⅛, 3/16 and ¼ in shaft sizes. Material is type #303 stainless steel. ★Gears designed to run with these worm are available in numbers

the NEW

USG SOLFRUNT®

(SOLID FRONT CONSTRUCTION)

the gauge with

BUILT-IN SAFETY!

There's safety with the new USG Solfrunt Gauge . . . behind the face is a solid metal wall! In the event of a Bourdon tube rupture, pressure is released through the large rubber blowout back. The case is of aluminum.

Like USG's Supergauge . . . with proper application . . . the Solfrunt is built to last a lifetime.

ARC-LOC MOVEMENT—Rugged beyond compare . . . broad generated gear faces, deep stainless steel bushings. Calibration adjustments from rear by merely removing blowout back.

SEGMENT—Stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

LEGEND ON DIAL—gives complete description of socket, Bourdon tube, and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

Solfrunt Gauges available in 4½", 6" and 8½" sizes. For complete information on case styles, materials of construction and connections, write for Publication 1819.

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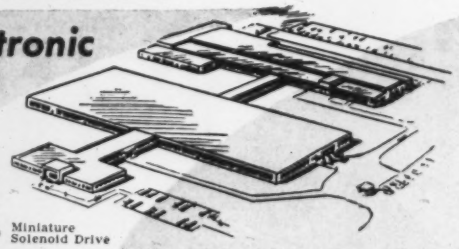
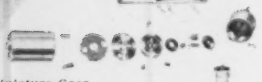
United States Gauge, Division of American Machine & Metals, Inc., 100 Clymer Avenue, Sellersville, Pa.

For more information circle **126** on inquiry card.

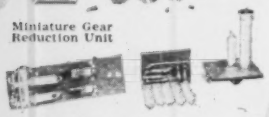
Sub-miniature Assemblies To Gigantic Electronic Systems.....



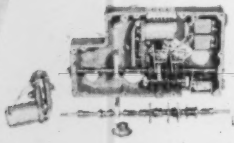
Miniature Solenoid Drive



Miniature Gear Reduction Unit



Sub-miniature Circuits —Transistorized Application



Tuning Drive Assembly

DAYSTROM INSTRUMENT has produced tiny precision assemblies . . . to gigantic gun directors and fire control systems — all within their modern 350,000 sq. ft. plant. When you combine Daystrom's team of skilled engineers with efficient production methods and modern facilities, you'll understand how Daystrom has been able to achieve mass production of such products—on time and at low cost—for every branch of the Armed Forces and industry.

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Radar Fire Control Systems, Mine Detecting Devices, Anti-Submarine Attack Directors, Catapult Speed Indicators, Servo Control Systems, Torpedo Assemblies.

. . . For the AIR FORCE

Capacitance Testers, All-Altitude Servo Indicators, Transistorized Receivers, R F Switches, Potentiometers.

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Mechanical Fire Control Systems, Fuzes, Communication Systems and other instrumentation for all branches of the Army.

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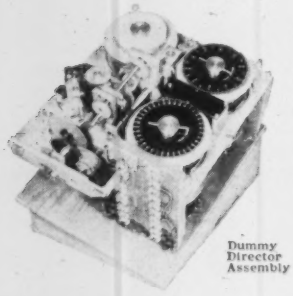
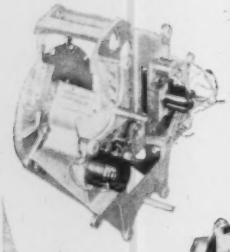
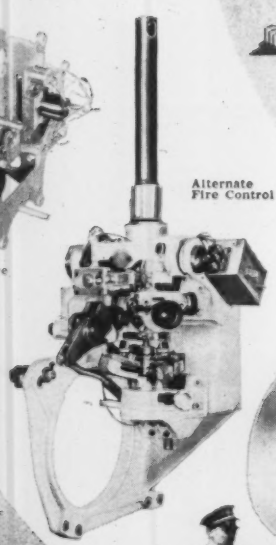
Write For Our Facilities Report



Dummy Director Assembly



Antenna Drive Housing



Alternate Fire Control

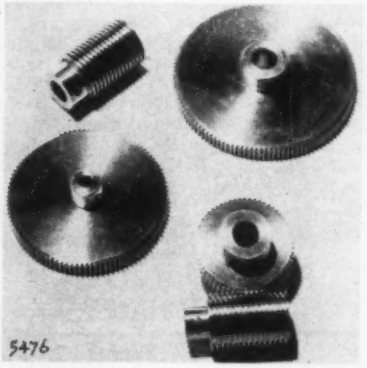
Mark 56 Director

DAYSTROM INSTRUMENT

ARCHBALD, PENNA.

Div. of Daystrom, Inc.

For more information circle **127** on inquiry card.



5476

of teeth from 60 to 120, in same three basic shaft sizes; material is best gear bronze.—*Pic Design Corp., 160 Atlantic Ave., Lynbrook, L. I., N. Y.*

For more information circle **455** on inquiry card.

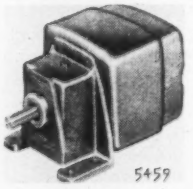
Turns-counting Dial

5548

New "900 Series Duodial" (superseding "W Series") permits greater sensitivity of adjustment and increases readability while diameter and over-all dimensions remain the same. It is available in four models, identical except for calibration of outer dial: "Model 901" 10 turns capacity; "902" 15 turns; "903" 25 and "904" 40.—*Helipot Corp., 916 Meridian Ave., So. Pasadena, Calif.*

For more information circle **456** on inquiry card.

Tachometer Takeoff Head



5459

New "Series 32" heads, for continuous-duty industrial applications, cover speed ranges between 100 and 5000 rpm for full-scale readings on any of maker's stationary tachometer indicators; feature a new long-lived dp-dt switch. Four different stainless steel shafts are available: 5/16-in round, ¼-in square, or one of two keyed shafts.—*Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

For more information circle **457** on inquiry card.

Non-rigid Teflon Tubing

New "Temprene" line of unusually flexible Teflon tubing for Class H service combines the properties offered by Teflon with complete flexibility down to –90°C (–130°F). Inside tubing diameters from 0.014 in to 0.112 in, with wall thicknesses from 0.008 in to 0.012 in (other sizes on special order). Available in a variety of solid and striped color code combinations. Colors conform to MIL-STD 104, and are light-, heat- and solvent-fast. Every foot of tubing is guaranteed to be 100% pin-hole checked for faults before shipment.—*Hitemp Wires, Inc., 26 Windsor Ave., Mineola, N. Y.*

For more information circle **458** on inquiry card.

Pneumatic Power Unit

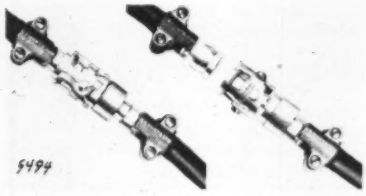
New "Model B-50 Cylinder Conomotor," a small version of "Series 50" line of pneumatically-positioned power operators, can produce stroke lengths

to 2 in and thrusts of 300 lbs in either direction; uses supply pressures to 100 psi and conventional 3-15 psi signal range. Thus it is especially suitable for services where heavy loads require high-accuracy positioning or throttling in a minimum of space.—*Conoflow Corp., 2100 Arch Street, Philadelphia 3, Pa.*

For more information circle **459** on inquiry card.

Quick Pneumatic Coupling

New "Quick-As-Wink" safety-type valve coupling permits air-operated equipments (valves, hose, pneumatic



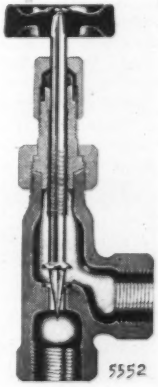
instruments, etc.) to be connected and disconnected rapidly and safely. Knurled sleeve controls air: one turn and air is trapped in line while air is exhausted from pneumatic device. Available in ¼, ⅜, ½, and ¾ inch sizes with variety of hose couplings for line air up to 250 psi.—*C. B. Hunt & Son, Salem, Ohio.*

For more information circle **460** on inquiry card.

VALVES

Needle Valves

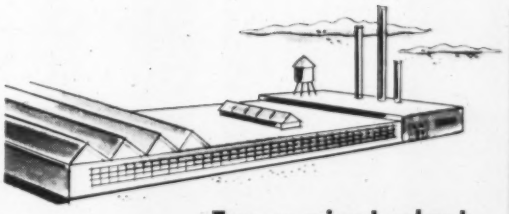
New needle valves provide precise control of small flows by combination of (a) long taper on working part of needle and (b) fine thread on stem; are available with or without a panel mounting flange, in five orifice sizes from 1/16 in to ⅜ in and four pipe sizes from ⅛ in to ½ in; in both angle and straight types. Body castings high-grade valve bronze; needles 18-8 stainless steel. Stainless steel bodies available on special order.—*Ideal-Aerosmith, Inc., 12909 S. Cerise Ave., Hawthorne, Calif.*



For more information circle **461** on inquiry card.

Inside-screw Gate Valve

New "Type 652" rising-stem gate valve, rated at 800 psi. and 800° F, is designed for instrumentation field; is

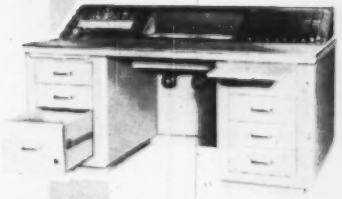


For a giant plant or a single laboratory loop

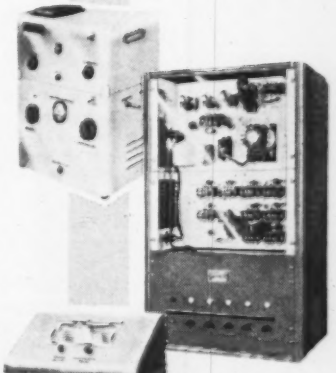
From *all-seeing* SARA that monitors entire plant operations to efficient units for detecting hazardous gases in laboratory or plants, Taller & Cooper control equipment is designed to meet industry's exacting needs specifically, economically, automatically. Here are four instruments that were developed by Taller & Cooper, which are easily incorporated in existing plants to perform various control and supervisory functions.

TALLER & COOPER
MONITORING AND CONTROL EQUIPMENT

is engineered for automatic supervision

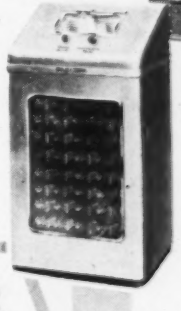


SARA—Sequential Automatic Recorder and Annunciator keeps an exact automatic log of as many as 500 separate plant operations continuously, automatically—and warns of any abnormal conditions.



Supersensitive Analyzer for laboratory or control loop detects hazardous gases as low as 5 parts per billion. In chemical control loop applications, it functions as analyzer, detector, monitor.

Telemetering System for remote control of entire plant operation— supervises multiple functions with only two wires. Affords complete plant control of 10, 16, 20, 32 or even 250 plant operations with the push of a button or switch.



AUTOLOG automatically prints a permanent record of all plant operations. Compact (48"x24"x15") AUTOLOG automatically supervises up to 50 trouble points, records occurrence of trouble conditions, as well as return-to-normal.

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0.001 microampere to 100 milliamperes? 0.1 volt to 30,000 volts DC?

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DOES!

Yes, the 800-B combines the utility of a voltmeter . . . millivoltmeter . . . milliammeter. . .millimicroammeter . . . ohmmeter . . . megohmmeter into one instrument. In addition, this "Portable Measurement Laboratory" features:

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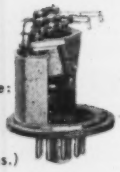
For more information circle **129** on inquiry card.

VHS* RELAY

(*Very High Sensitivity)



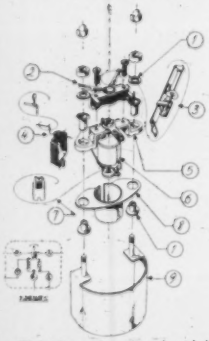
Model 266

Sample specs. are: 0.2 micro-amperes, (12,000 ohms coil) or, 0.1 millivolts, (5 ohms.)

• The VHS is a balanced armature, Alnico magnet type relay. It is internally shock-mounted and resistant to vibration. The screw-on cover is gasket sealed. It can be opened and resealed.

Connections: 9 pin octal style. Dimensions: 1¾ diameter x 2¼ long. Weight: 4 ounces. Sensitivity: Infinite variations from 0.2 Ua. to 10 Amp. or 0.1 Mv. to 500 volts, self contained. Higher volts or amps with external multipliers. A.C. rectifier types. Trip point accuracies to 1%. Differential 1%. The degree of resistance to shock and vibration primarily depends upon sensitivity and type of action wanted. In general, the relays will not be permanently damaged by shocks of 100 G's and vibrations up to 2,000 cps at 3-4 G's. Most sensitive relays may close their contacts under these conditions.

Contacts: SPST or SPDT, 5-25 Ma. D.C. Other ratings to ½ Amp. A.C. A locking coil gives high pressure and chatter free contact under shock and vibration. Prices Prices: $20-$80. Delivery 4 to 6 weeks. Assembly Products, Inc., Chesterland 10, Ohio.



Write for explanation of symbols

Booths 425-426, Automation Show, Nov. 14-17, Chicago

For more information circle **130** on inquiry card.

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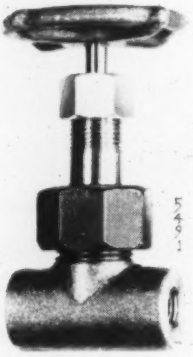
NEW INSTRUMENTS



available in ¼-in and ⅜-in sizes, weighing 18 and 17 oz, respectively. Forged steel body, stainless steel trim, and hardened chrome plated gate; also available with 304 stainless body and trim.—*Worcester Forged Steel Valve Co., 16 Parker St., Worcester 10, Mass.*

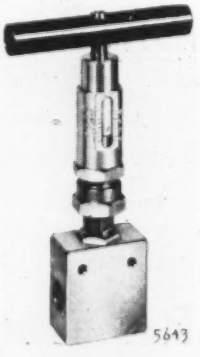
For more information circle **462** on inquiry card.

Control Valves for Flashing Liquids

New diaphragm-motor control valves feature new "Flash-Flo Plug" (illustrated) which eliminates destructive vibration, trim deterioration, and high noise level often occurring in valves on flashing-liquid service. With conventional design, most of potential energy becomes kinetic and, by cavitation, is imparted to downstream piping as vibra-Plug" design, threaded tion. In "Flash-Flo holes geometrically spaced around plug skirt create turbulence and distribute energy release over a large surface area, so that potential energy is converted directly to heat by liquid's internal turbulence, leaving little kinetic energy available for damage to piping. Temperature rise of metals is almost unnoticeable. Available sizes 3 to 16 in; single- or double-seated, plug material and flow characteristics to user specifications.—*Hammel-Dahl Co., 175 Post Road, Providence 5, R. I.*

For more information circle **463** on inquiry card.

High-pressure Test Valve



New high-pressure valve with a micrometer stem, said to be "perfect for bleeding and metering pressure letdown control," permits micrometer control through principle of differential screw threads. Orifice opening is "so delicately measured you can even 'mic a bubble.'" One complete revolution of handle opens valve 0.015. A positive stop at '0' prevents valve from being thrown

out of alignment or seat ruined by over-tightening. Available for pressures up to 60,000 psi in a complete range of tubing sizes up to 9/16-in.—*High Pressure Equipment Co., Inc., 1222 Linden St., Erie, Pa.*

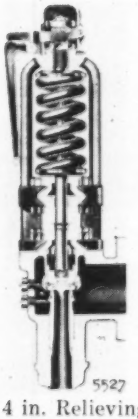
For more information circle **464** on inquiry card.

Diaphragm-motor Valves

New diaphragm-motor valves have a bolted-clamp-type stem connection which allows stem adjustment of 50% of total travel in either direction; will not shake loose from vibration or rotational inner-valve forces; and can be field-disconnected without damage to stem. Buna-N molded diaphragm with Nylon insert retains flexibility at low ambient temperatures; provides linear relation between instrument signal and stem travel. Top-work can be removed without disturbing stuffing box (of bolted clamp type with Teflon packing).—*Fisher Governor Co., Marshalltown, Iowa.*

For more information circle **465** on inquiry card.

Safety Valves

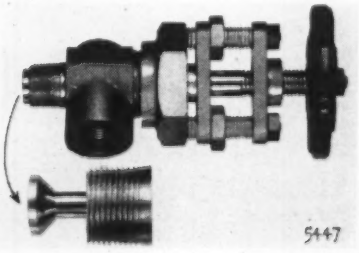


New "Style HC" (high capacity) safety valve, because of its high discharge capacity, is said to reduce number of valves required, and to enable user to valve a generating unit at minimum cost and with assured safety; is built around maker's reaction principle. New line is designed for pressures ranging to 3,000 psi and temperatures to 1050°F; available with flanged outlet, and either welded or flanged inlet. Sizes from 2 in to 4 in. Relieving capacity is ASME certified. A flat-seat disc insert, designed and contoured to be in thermal balance with nozzle, provides thermal flexibility which maintains uniform seat contact at all times.—*Crosby Steam Gage & Valve Co., 43 Kendrick St., Wrentham, Mass.*

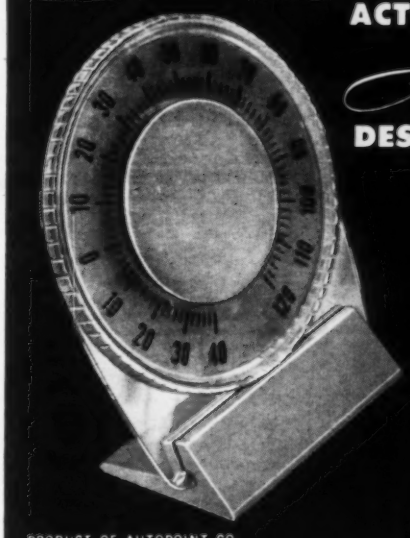
For more information circle **466** on inquiry card.

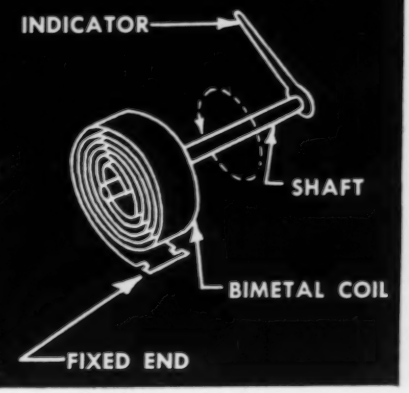
Drain or Sampling Valve

New "No. 23" is completely self draining; valve stem seats on outside of valve body. Especially desirable for



HOW CHACE THERMOSTATIC BIMETAL ACTUATES THE *Autopoint* DESK THERMOMETER





The Autopoint Desk Thermometer illustrates one of the simplest applications of a bimetallic element—that of operating an indicator over a predetermined temperature range. The coil of Chace Thermostatic Bimetal which actuates this device is calibrated at the factory to assure precise temperature readings over a long period of time. Since this thermometer is also used to indicate more extreme outdoor temperatures, it has an effective range of −40°F. to +120°F. This application requires a bimetal material with a high deflection range and high torque properties, such as is found in Chace No. 2400 Thermostatic Bimetal.

A coil of Chace Thermostatic Bimetal is securely anchored at its one end to the backplate of the thermometer. The other end of the coil is fastened to the stem of the dial indicator. Temperature variations between −40°F. and +120°F. cause the coil to rotate in a predetermined arc, moving the indicator to register the correct ambient temperature.

Chace Thermostatic Bimetal is available in 29 different types, in strip and coil forms, as well as in completely fabricated elements made to customer specifications. Write now for our free 36-page booklet, "Successful Applications of Chace Thermostatic Bimetal."

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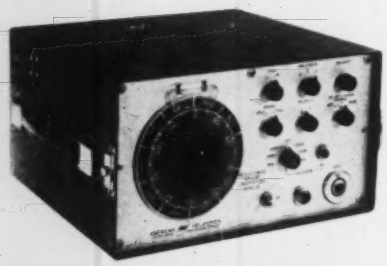
For more information circle **132** on inquiry card.



Resistance Bridge Indicator—Model 101A

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- Pressure Pick-ups
- Position Pick-ups
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NEW INSTRUMENTS

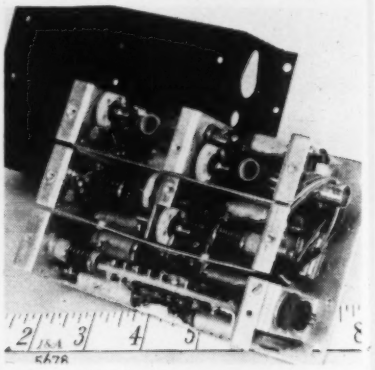
installations where valve seat must be inside vessel wall in order to prevent liquid from remaining in nipple and valve. Outside screw and yoke construction meets high-temperature or corrosive conditions where inside threads cannot be tolerated. Valve is foolproof, in that stem has left-hand thread, thus allowing operation in normal direction of standard valves. Pressures up to 4000 psi @ 100°F, or 1000 psi @ 750° F.—*Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.*

For more information circle **467** on inquiry card.

MISCELLANEOUS

FM Transmitter

New "Model R-3011-1" airborne unit, said to "provide maximum accuracy and dependability under the most adverse environmental conditions of shock, vibration, temperature,

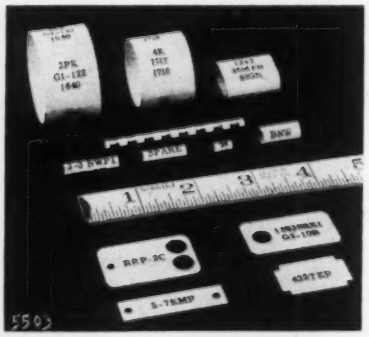


etc.," is a crystal-controlled subminiaturized package with exceptional linearity gained by double modulation circuitry. Power output 3 watts; frequency range 215-235 Mc.—*Radiation, Inc., Melbourne, Florida.*

For more information circle **468** on inquiry card.

Plastic Sleeves and Tags

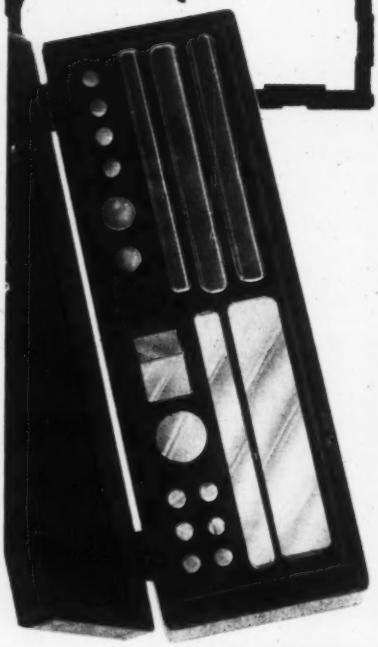
New all-plastic circular sleeve tags and flat tags, for identification markings on all sizes of wires and cables,



piping and similar systems, are clearly legible; resist oil, grease, dirt and dampness; can be produced to customers' specifications. Colored plastics or color printing processes can be employed for special coding.—*Allegheny Plastics, Inc., Route 51 and Thorn Run Road, Coraopolis, Pa.*

For more information circle **469** on inquiry card.

Now, an Engineer's Precision Optics Design Kit



HTL's OP-KIT

Houston Technical Laboratories offers engineers, chemists, and physicists an optics design kit from which to experiment and determine their exact optical requirements. The OP-KIT contains 19 selected optical components (see photograph).

A fitted pocket case (9⅜"x 3"x 1⅝"), the OP-KIT is a convenient and permanent *specimen library*. The part number, exact dimensions, and specifications of each component are printed in the box cover for ready reference. All optic samples shown are ready for immediate delivery in any quantity. And from HTL, you receive CUSTOM PRECISION at PRODUCTION PRICES!

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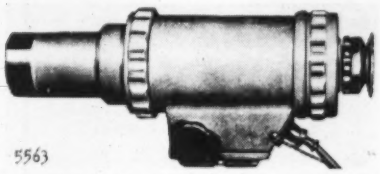
For more information circle **134** on inquiry card.

Infrared Viewer

New infrared viewer comprises a receiver (shown) and a 20,000-vdc power supply. Receiver comprises an

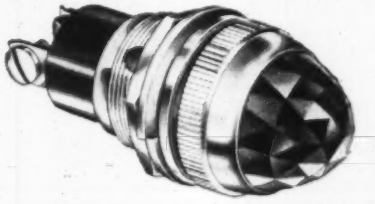


optical system featuring four nitrogen-filled lenses, and an electronic system featuring ten components encapsulated in epoxy.—*Meyer-Opticraft, Inc., 39 W. 60th St., New York 23, N. Y.*

For more information circle **470** on inquiry card.

Oil-tight Pilot Lights

New "Dialco Oil-Tight Pilot Lights" for severe industrial service are of streamlined design that derives rug-

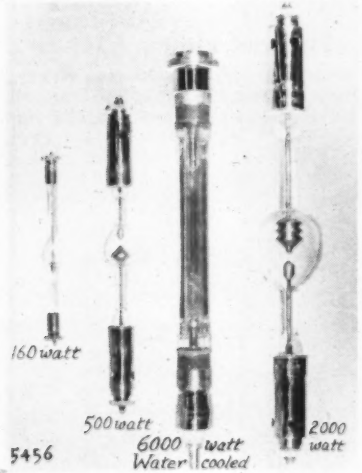


gedness from simplicity. Among other unique features: provision for retained oil-resistant gaskets; glass lenses in several shapes with omnidirectional light spread; discs (with words, letters, or numbers) inserted behind flat glass lenses; wide range of incandescent lamps, with screw or bayonet base, as well as several neon types; full range of lens colors.—*Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.*

For more information circle **471** on inquiry card.

Xenon Light Sources

New models of German-made xenon-arc lamps are available in U. S. Apparent color temperature about 5800°



K (white light); efficiency 36 lumens per watt. Enclosed-arc quartz lamp produces no smoke, flame or ash; has a high-intensity extremely compact point source (even in 2000-watt size, arc length is 4 mm, much smaller than

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SINGLE RANGE 100,000 STEPS

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- GENERATE VOLTAGE GATES
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- Internal 1 megacycle crystal oscillator time base
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- Preset counter up to 1 megacycle

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For more information circle **135** on inquiry card.

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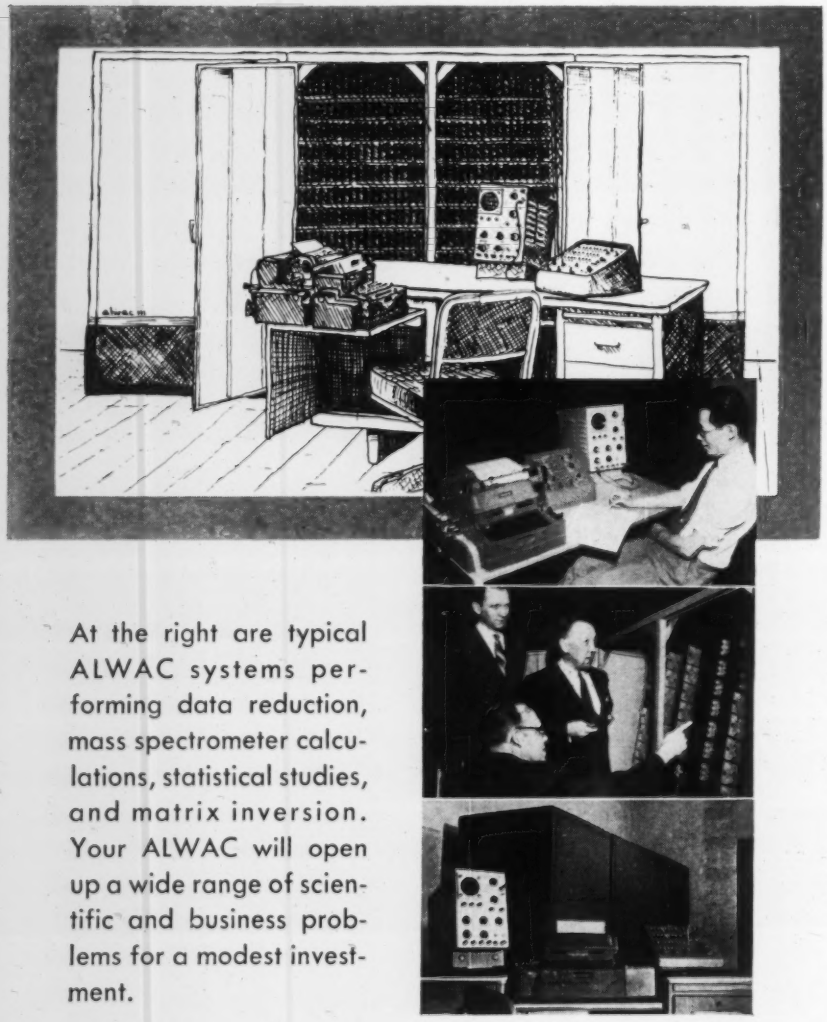
THE IMPROVED ALWAC III now in quantity production can automatically modify the address as an instruction is picked up. Also, the new model picks up two instructions at once. When the first is finished, the second is available immediately. This affords a higher percentage of data addresses that give optimum fast-access operation (1 millisecond).

In its 4,096 or 8,192-word memory ALWAC stores two instructions per word. Input and output are all decimal and alphanumeric. Punched-card handling at 100 a minute with simultaneous computation, and magnetic tape storage complete the ALWAC picture for the present.



At the right are typical ALWAC systems performing data reduction, mass spectrometer calculations, statistical studies, and matrix inversion. Your ALWAC will open up a wide range of scientific and business problems for a modest investment.

LOGISTICS RESEARCH INC.

141 So. Pacific Ave • Redondo Beach, California

For more information circle **136** on inquiry card.

conventional sources of equal wattage or brightness). Rated life 800 to 1000 hours. Water-cooled 6000-watt lamp; designed specifically for diffuse lighting, has arc gap 110 mm long and 5 mm wide.—*Macbeth Sales Corp., P. O. Box 950, Newburgh, N. Y.*

For more information circle **472** on inquiry card.

Professional Camera

New "Rembrandt Master Pictorialist" 8x10 is said to have been "built in answer to the demand for an exceptionally rugged camera with oversized, large lensboard." It also accepts reducing backs for smaller negatives down to lantern-slide size. For use with behind-the-lens shutter, there are built-in air, as well as electrical connections for synchro. No special tools for shutter installation needed.—*Burke & James Inc., 321 S. Wabash Ave., Chicago 4, Ill.*

For more information circle **473** on inquiry card.

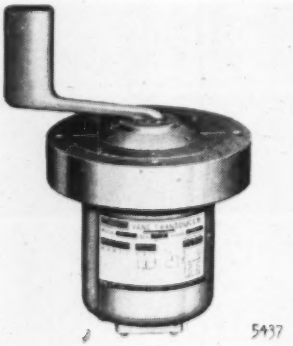
Rocket Fire Detector

New "Fireye" rocket fire detector spots faultily-fired or improperly-released rockets on jet fighter planes in 0.0005 sec; weighs about 4 oz; actuates a relay which sets off rocket cradle release mechanism to allow rocket to burn out completely, in perfect safety to pilot and plane. Primary detector of new system is a lead sulphide photocell, said to function by "detecting incipient infrared radiations."—*Electronics Corp. of America, Cambridge, Mass.*

For more information circle **474** on inquiry card.

Angle-of-attack Pickup

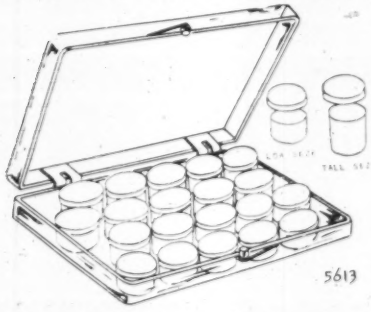
New "Model 25116 Aerodynamic Angle of Attack Transducer" can "filter out" non-significant localized high-frequency airstream fluctuations; is available with VDR, synchro, or both types of outputs and in ranges up to 60°.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena, Calif.*



For more information circle **475** on inquiry card.

Small-parts Storage Set

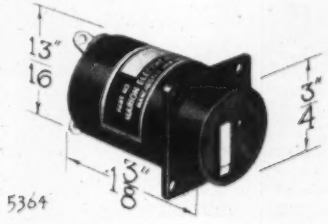
New "Micro Storage Set" contains 20 frosted glass containers (each with transparent cover) 13 mm. diam, furnished either 13 mm. high or 7 mm. high. Twelve sets (for 240 lots of material) are furnished in one flat tray.—*R. P. Cargille Labs., Inc.*, 117 *Liberty St., New York 6, N. Y.*



For more information circle **476** on inquiry card.

Annunciator

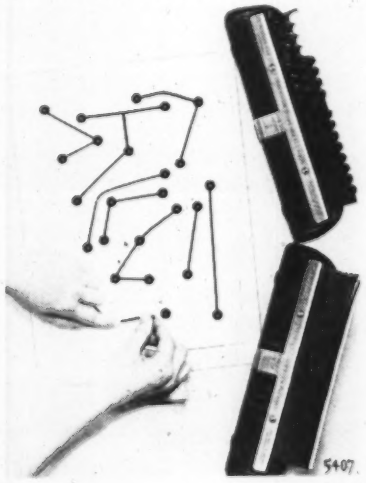
New "HCM ¾ Universal Annunciator" is a 1.3-oz ¾-in diam. vibration-resistant d'Arsonval type indicator utilizing maker's "Coaxial Mechanism," especially suited to aircraft use but also useful as a flag alarm or miniature null indicator in servo and control systems. Unit is glass-to-metal hermetically sealed; is available in many ranges, such as ua, ma, mv, volt, etc.—*Marion Electrical Instrument Co., Manchester, N. H.*



For more information circle **477** on inquiry card.

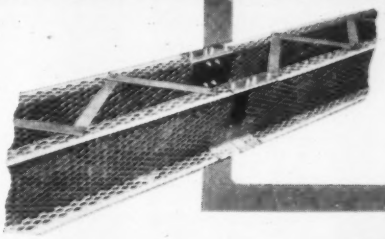
Pre-cut Shapes for Graphic-circuit Layouts

New "Self-Sticking Terminal Circles and Connector Strips" represent a new method "drawing" master layouts; obviate need of hand-drawing, inking-in and opaqueing master lay-

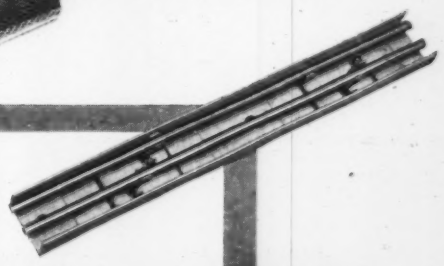


INSTROF

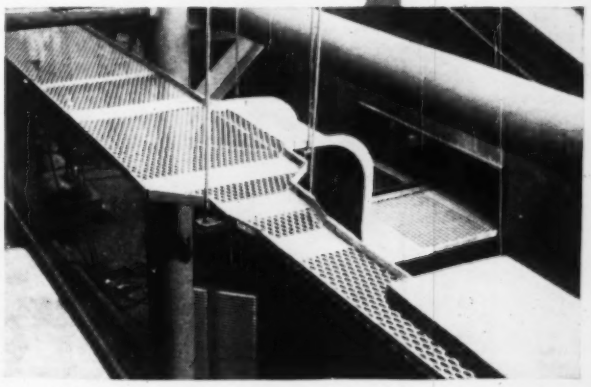
for the support of instrument tubing



BOX GIRDER—for long unsupported span lengths.



TUBE RACE—for branch run.



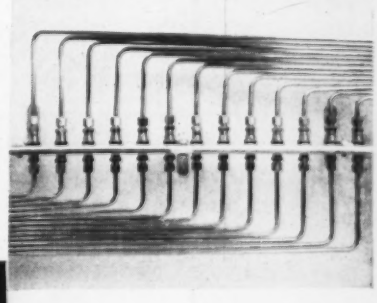
The Instrof System installed in a large South-West Coast Chemical Plant. All fittings are stock items which were rapidly assembled on the job. System is ready for placement of tubing.

Instrof is a system of prefabricated metal trough specifically designed to give continuous support and protection to instrument tubing. It is the most versatile system of its kind on the market today, and can be readily assembled at the job site in an extremely short time. Once installed, it requires no maintenance.

Instrof is available in widths of 3", 6", 9", 12", 18", and 24" with a complete range of fittings for all widths. These fittings enable the system to follow walls, change direction and elevation, and to change from one width to another—in short, to conform to any plant layout.

For further information on how the Instrof System can help solve your tubing problems, write today for the new Instrof Catalog. Ask for Bulletin I-8.

The Instrof Bulkhead Bar is a light section of channel with ¼" brass couplings mounted on 1½" center. It can be used wherever straight or angle tube terminal connections are required, such as junction boxes, panel boards, etc. It is especially adaptable to mounting on Instrof sections. The standard bar contains 40 ¼" brass couplings and is five feet long. Other sizes can be manufactured to customer's specifications.



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INCORPORATED

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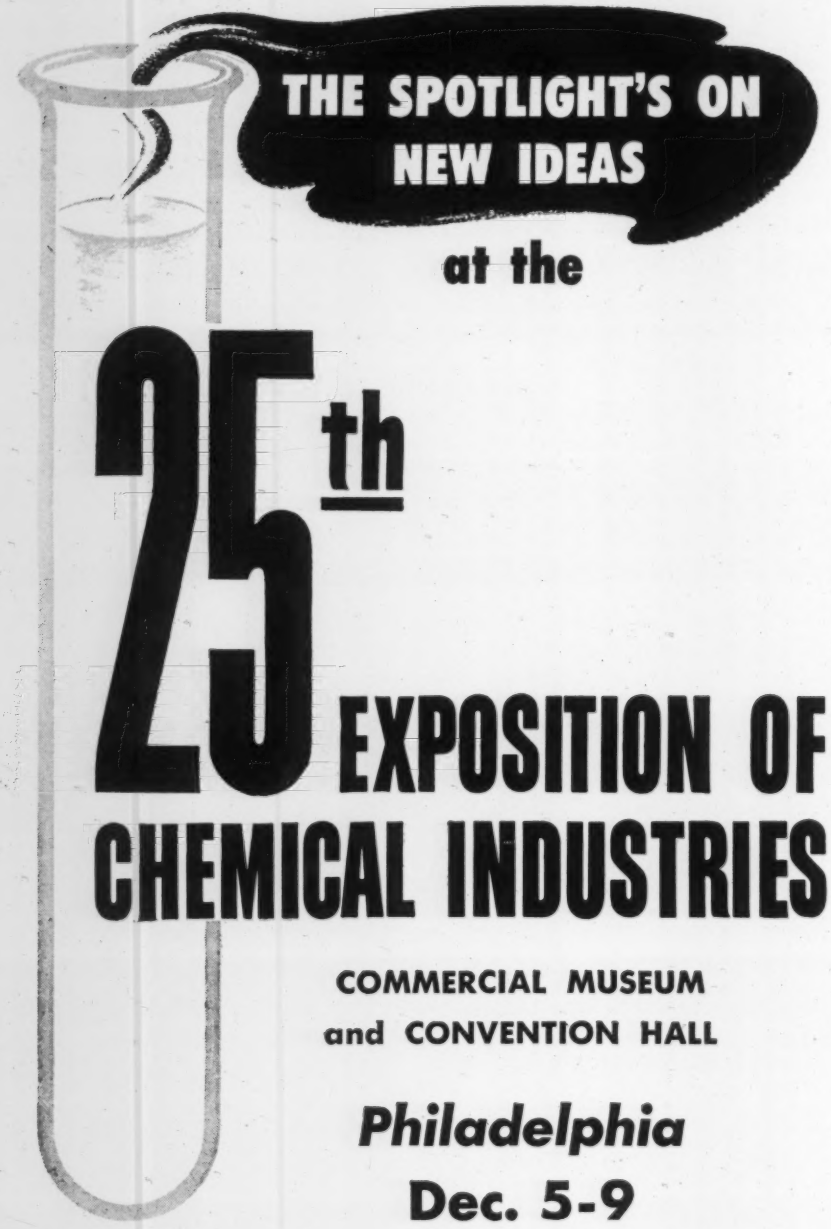
For more information circle **137** on inquiry card.



If you're a chemist . . . chemical engineer . . . production man . . . executive—there's no better, no easier way for you to keep up with today's developments than by taking time out to visit this important exposition! Over 500 informative exhibits throw the spotlight on the new facts, ideas, materials and methods that you must have at your fingertips.

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For more information circle **138** on inquiry card.

outs. They are pre-cut pieces of photographic tape especially suited to photographic reproduction; require no touch-up on photo plates; won't reflect into camera when master layout is photographed. Both circles and strips are furnished on handy dispenser cards. Circle range from ¼ in to 1⅛ in OD; strip widths 1/16 in, ⅛ in and ¼ in. Special sizes and shapes can be furnished.—*W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 12, Wis.*

For more information circle **478** on inquiry card.

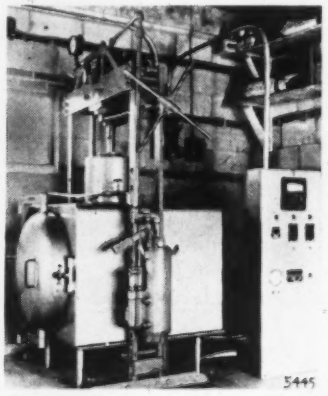
pH Glass Electrodes

New pH electrodes incorporate "E-2 Glass," especially suited for high pH measurements, replacing Type E glass in maker's original blue-tipped alkali-resistant electrodes. Electrodes with "E-2" glass are especially valuable in range above pH 10; are also good over entire 0-14 pH range at temperatures from 15 to 100°C and offer improved resistance to acids, surface deterioration, aging and alkalis.—*Beckman Instruments, Inc., Fullerton, Calif.*

For more information circle **479** on inquiry card.

Vacuum Furnaces with Pressure Attachment

New high-temperature vacuum furnace, built in conjunction with a high-pressure press, can be designed for

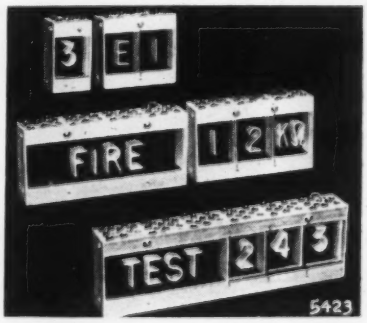


temperatures up to 2400°F and 29 in of vacuum; both temperature and vacuum automatically controlled.—*K. H. Huppert Co., 6830-32 Cottage Grove Ave., Chicago 37, Ill.*

For more information circle **480** on inquiry card.

Digital Displays

New miniature digital in-line readouts consist of engraved Lucite plates, arranged in depth, with numbers less

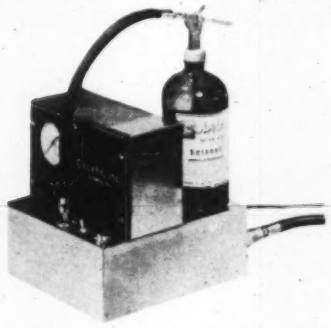


than ½-in high, each illuminated by a miniature aircraft-type bulb. New design reduces cross-lighting. Units are available in any number of decades and with special symbols as well as verbal displays.—*Electro Instruments, Inc., 3794 Rosecrans St., San Diego 10, Calif.*

For more information circle **481** on inquiry card.

Component Cleaner

New portable cleaning unit utilizes maker's high-velocity spray technique for cleaning electrical and electromechanical components: it micro-filters, heats and regulates compressed air to 80 psi and employs a high-velocity sprayer and a specially-prepared solvent which is non-flammable, non-corrosive and non-polar, and meets MIL specs.—*Cobehn, Inc., Passaic Ave., Caldwell, N. J.*



For more information circle **482** on inquiry card.

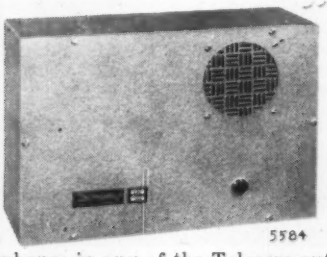
Transistorized Repeater

New "AT-2" telephone repeater is believed to be the first commercially-available equipment of this kind to utilize transistors instead of vacuum tubes. Field tests indicate that in some cases it obviates the need for loading coils; and that when located near electrical midpoint of line, transistorized repeater provides a gain of up to about 10 db. (When installed as a terminal repeater, gain is somewhat less.) On cable utilizing loading coils, maximum gain under ideal conditions will be from 6 to 8 db.—*Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.*

For more information circle **483** on inquiry card.

Speaker Phone

New Speaker Phone is said to offer "for the first time two-way communication between a loud speaker and all telephones in any of the Telecom automatic dial systems." Called party can talk back to calling party by merely addressing Speaker Phone, obviating need of push-to-talk levers and buttons for either party. Only a single pair of wires is required.—*Telecom, Inc., 1019 Admiral Blvd., Kansas City 6, Mo.*



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For more information circle **484** on inquiry card.

USS

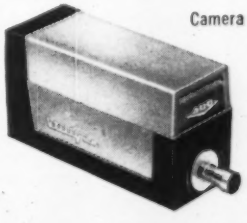
FAIRLESS WORKS uses DIAMOND INDUSTRIAL TV to Improve Operation and Cut Costs

Arrow points to Diamond ITV camera (in protective housing) used to watch slab positioning.

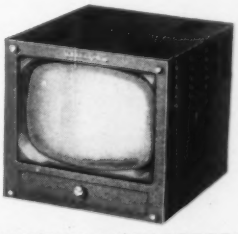
Four slab reheating furnaces are charged by one operator using Diamond ITV at Fairless Works of the U. S. Steel Corp. Slabs are aligned properly eliminating danger of serious damage to furnaces. Operating costs are reduced.

You, too, probably can use Diamond ITV to substantial advantage. For case histories and suggestions, get in touch with your Graybar Distributor or use the coupon below.

Operator at pulpit SEES on the Diamond ITV screens when slabs are in correct position for charging two end furnaces.



Camera



Monitor

7258

Distributed by GraybaR ELECTRIC COMPANY

DIAMOND POWER SPECIALTY CORP.
"FIRST IN INDUSTRIAL TELEVISION"
ELECTRONICS DEPT., P.O. BOX 415HH
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Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

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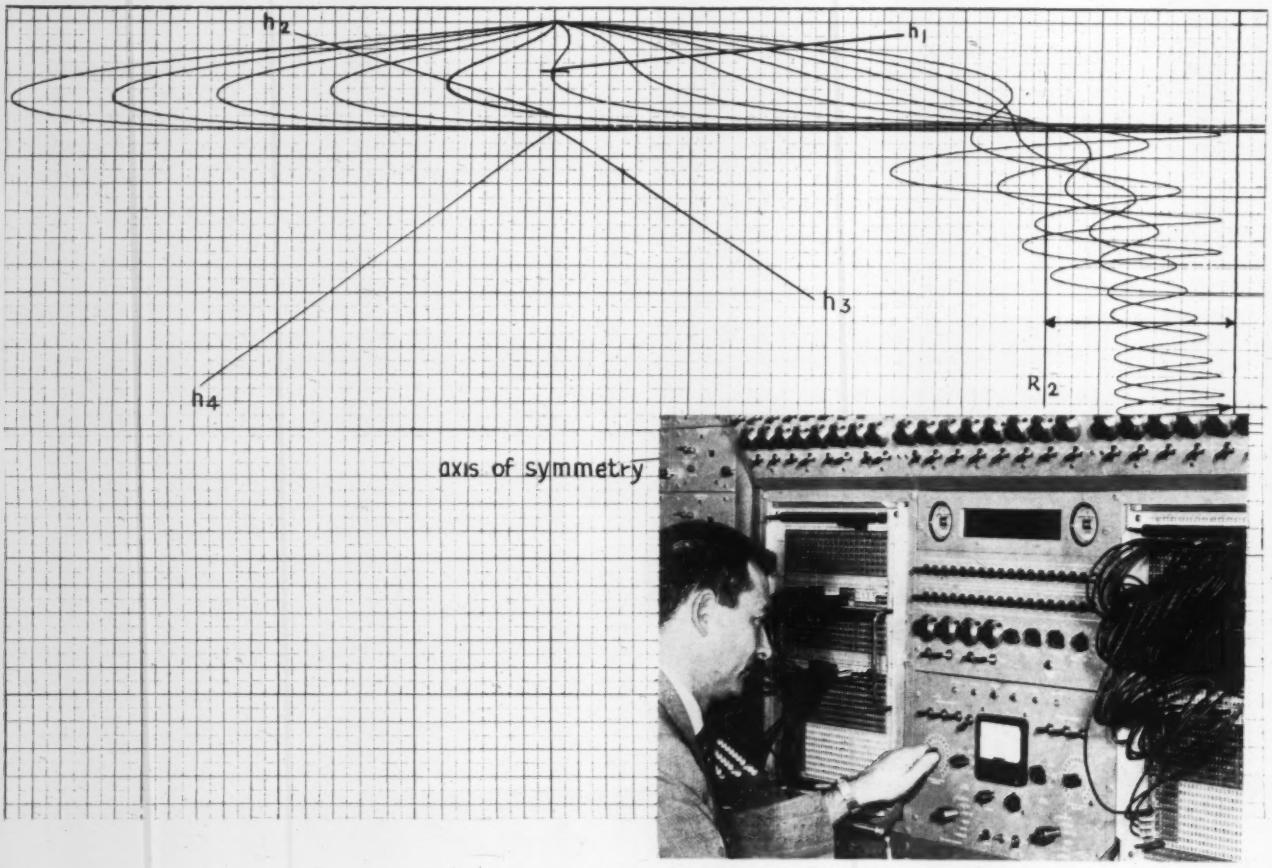
For more information circle **139** on inquiry card.



Application in solid state physics . . . a demonstration of the versatility of EAI Computers . . .

One of the complex problems faced by a certain manufacturer, who was concerned with an industrial method of purifying silicon rods, was to determine the physical conditions which lead to stable liquid zones when the rods were subjected to concentrated heat, as well as the shapes of the hanging liquid drops.

This is a problem typical of those solved so efficiently by Electronic Associates' Analog Computing Equipment. This equipment made available to the manufacturer a graphic solution of the desired zone and drop shapes (see illustration above). In addition, it also provided valuable information on the maximum zone heights and the possible variations realized by variations in rod diameters.

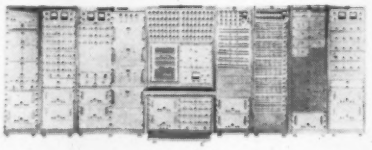
Another demonstration of the facility and flexibility of EAI's Computing Equipment. The equipment that is renowned for its speed, accuracy, and unique system of expansion.

Complete details on this equipment with its automatic read-outs, problem checks, and high speed servos will be forwarded on request.

Write Department IA-12, Electronic Associates, Inc., Long Branch, N. J.

Information also will be furnished on request concerning EAI's Computation Center at Princeton, New Jersey, where the use of Precision Analog Computing Equipment may be obtained on a time-rental basis.

EXPANDED 16-31R ANALOG COMPUTER



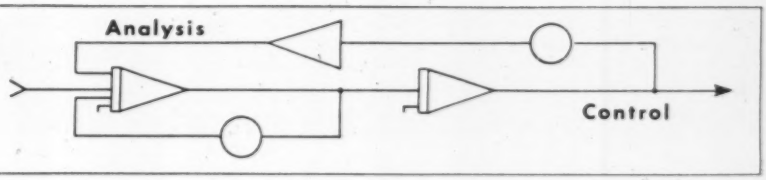
ELECTRONIC ASSOCIATES *Incorporated*

EAI SETS THE **P** PRECISION **A** ANALOG **C** COMPUTING **E** EQUIPMENT

LONG BRANCH · NEW JERSEY

For more information circle **140** on inquiry card.

The SIMULATION COUNCIL Newsletter



John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

Western Simulation Council
Norman L. Irvine, Aerojet-General Corporation, Azusa, Calif.; Chairman, Steering Committee.

Midwestern Simulation Council
R. R. Weber, Cincinnati Milling Machine Co., Cincinnati, Ohio; Chairman, Steering Committee.

Eastern Simulation Council
Harold K. Skramstad, National Bureau of Standards, Washington, D.C.; Chairman, Steering Committee.

Southeastern Simulation Council
For information write W. K. McGregor, ARO, Inc., Tullahoma, Tennessee

Bits

Again this month we have more to report than we can cover in these columns.

Ro Favreau has furnished us with very complete minutes of the July meeting of the Eastern Simulation Council which we have had to cut rather severely—mostly by deletion of the equations.* And your Editor and Secretary have covered the San Francisco area meeting of the Western Simulation Council, WESCON (the Western Electronic Show and Convention), and the Los Angeles ISA Instruments-Automation Convention and Exposition. We can describe for you some of the goings-on at the WSC meeting, but our comments on conventions in general and WESCON and ISA in particular are a story in themselves. Suzy and I will write it, but we don't know that Milt Aronson (or anyone else) will print it.** It is sufficient to say here that we think "To Convene or Not to Convene" (i.e. are conventions worthwhile?) is a question worthy of consideration.

*These were generalized equations representative of those used in the simulation of an aircraft or missile problem in three dimensions. We did not include them because (1) this is not a technical Newsletter; (2) these generalized equations can be obtained elsewhere (probably from Mr. L. Neustadt, Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y., who had them reproduced for distribution); and (3) we think equations make dull reading.

**We bring you some of John's comments (unedited) on pages 1638-39 of this issue—and his "To Convene or Not to Convene" will be an editorial in an early issue (as soon as he writes it!).—MHA.

Pieces

Meeting of the Eastern Simulation Council at the Naval Air Development Center

By Romeo R. Favreau (Electronic Associates, Monmouth Junction, N. J.)

The subject of the meeting, held at Johnsville, Pennsylvania the afternoon of 11 July 1955, was *Three-dimensional Simulation.*

Tremblay on 3-D Simulation

Dr. H. K. Skramstad (National Bureau of Standards, Washington, D.C.) opened the meeting and conducted a brief discussion session, after which *Hal Tremblay* (NADC, Johnsville, Pa.) told about Typhoon's attack on a three-dimensional problem.

Using his hypothetical miss-ile, "Miss Eastern Simulation Council," Hal pointed out that the closed-loop problems under discussion are usually represented by a series of blocks with equations describing what takes place in each block. He then wrote the equations for the guidance, control surface motion, aerodynamic, angular velocity, linear velocity, and ground coordinate blocks on the board and explained them.

There were 24 equations in all, which caused *Leonard Pode* (David Taylor Model Basin, Washington, D.C.) to ask how much equipment this type of problem required. Hal answered that a typical problem may require about 300 to 400 amplifiers and about 12 multipliers. Asked how his accuracy was for such a large amount of equipment, Hal replied that the saving factor is that all these problems are closed loop. Nevertheless, they run off at least one digital check solution for every large problem. Using a CPC, this represents about 60 to 100 hours for a 30- to 60-second solution.

Neustadt on 3-D Flight Simulator

Mr. L. Neustadt (Reeves Instrument Corp.) was the next speaker and presented Cyclone's approach to three-

dimensional simulation. Instead of writing equations on the board, Mr. Neustadt passed out papers entitled "Flow Diagram for a Three-Dimensional Flight Simulator."

Neustadt indicated that the equations used at Cyclone were very similar to those at Typhoon. He pointed out that in all large problems solved at Cyclone, earth axis and body axis (not wind axis) were used. However, the resolution from one axis to the other was performed with resolvers rather than by using direction cosines.

The most troublesome part of the entire simulation is to generate the coefficients used to obtain the body forces or moments. These coefficients are usually functions of angle of attack and/or Mach number, which may be generated by using diode function generators or tapped pots.

The advantage of tapped pots is that a function may be generated and multiplied by a variable all in one element.

The real trouble comes when the coefficients are functions of two or three variables. Usually these complex functions can be represented by various mathematical approximations. When a function of two variables must be generated, however, one possibility is to generate various functions of one variable with diode function generators and place these functions on the taps of a tapped pot, which is then driven by the second variable.*

Indicating how some problems can become complex, Mr. Neustadt said that in the case considered, seven functions of two variables (requiring diode function generators and tapped pots) were required. In addition, one coefficient was simulated as a product of two functions of one variable, and 13 coefficients were generated as the sum of two functions of one variable.

An additional problem arising with the use of resolvers is continuous roll. This is usually solved by a relay system which changes the sign of the sine and reverses the rotation of the resolver.

Project Cyclone has an Elecom digital computer which is used about three quarters of the time to obtain check solutions for their analog problems. Usually one or two solutions are obtained for each large problem. Approximately 80 hours' running time is needed for one solution of a problem requiring about 300 analog amplifiers.

Mr. J. Lehmann (RCA) asked about the limiting speed of the servos or resolvers. Mr. Neustadt answered that it is about 100 deg/sec, but if this must be exceeded a time base change is introduced. When continuous resolving is required they try not to exceed 40 or 50 degrees per second because of the reversals required at 180 degrees. As to accuracy, Neustadt stated that they usually match frequencies to about 2% and the damping to about 5%.

*We have a paper, "An Electronic Circuit for the Generation of Functions of Several Variables" (reprinted from 1955 IRE convention record, part 4), by Hans F. Meissinger (formerly of Project Cyclone and now of Hughes Aircraft), which seems to offer a good solution to this problem without use of tapped pots. Willard Uplinger, who has been experimenting with Hans' technique at the Naval Air Missile Test Center, Pt. Mugu, Calif., reports that preliminary results indicate that though there are some limitations (corresponding segments of all curves of a family must be parallel), the method offers a powerful tool for generating many of the functions of two or more variables commonly found in practice.

Trembath on 3-D Simulation at DACL

Mr. N. Trembath (Dynamic Analysis and Control Laboratory, M.I.T., Cambridge, Mass.) was the next speaker. He indicated that the equations used at DACL were quite similar to those used at Cyclone. That is, Euler angles are used to describe the orientation of the body instead of direction cosines. However, the main difference occurred in the type of equipment used for resolving. At DACL the basic component is a 400-cycle suppressed-carrier electromechanical rate servo integrator. Each one of these units is housed in a separate rack. However, this rack has all the associated equipment required to drive and unload five output units on each shaft. These output units may be linear pots, tapped pots, or AC-type resolvers. For a three-dimensional simulation these units would be driven by the body angular rates, and the output shaft positions would be the pitch, roll, and yaw of the body. In addition, the output units on the shafts can resolve a vector from one coordinate system to another with no extra equipment required.

Another major problem of three-dimensional simulation, Mr. Trembath agreed, was that of function generating, especially functions of two variables. These may be simulated by power series, Fourier series using resolvers, and sometimes as the product of two functions of a single variable. When these techniques are not adequate, a special function generator of two variables (developed at DACL) is used. The function is simulated by a plaster-covered plywood model in three dimensions such that the height of the surface above a reference plane is the function of the two variables. A mechanism similar to a plotting board positions a pick-off probe which drives a linear potentiometer to give a voltage proportional to the height of the surface above the reference. The cost of a model for a two-dimensional function is about $50 to $100, and the accuracy can be as good as 0.1% depending on how the models are fabricated. The probe can follow a 70° slope at full speed with an accuracy of about 1.5%.*

*What is full speed, Mr. Trembath, and *how* are models made accurate (at all points?) to 0.1%?

Lehmann on Methods for Coordinate Transformation

Mr. J. Lehmann then summarized the methods of coordinate transformation—direction cosines and Euler angles. He stated that in using the Euler angles we seem to have only three quantities. This is not strictly true, since the sine and cosine of each angle is required.

With the direction cosine, nine quantities are required and this represents a certain amount of redundancy. This redundancy could be used, but this is not being done at present because it is expensive in equipment. With direction cosines only integrators and multipliers are used, but the system is subject to drift. With fast multipliers there is no limitation on time scaling.

When using the Euler angles the drift problem is not present, but since mechanical units must be used there is a limitation on the angular rates. The direction cosine method is not subject to gimbal lock like the Euler angle system. Actually, when the Euler angles are used, three direction cosines must be generated to resolve the gravity vector. The main disadvantage of the direction cosine system is that the coordinate system may drift out of normality or orthogonality if the redundancy is not built

in. To build in the redundancy, approximately twice the amount of equipment is required. One advantage of the Euler angle system is that very often these angles are required in a problem and do not have to be generated from the direction cosines as an extra step.

Comments on Submarine Simulation

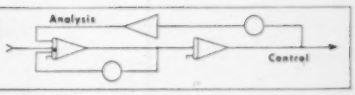
Dr. Pode mentioned that a large submarine simulator is being built for the Special Devices Center (Port Washington, N. Y.) which will be three-dimensional and will be used in the training of crews. However, in general, submarine simulation has not gone as far as aircraft simulation. The geometry is not the main problem, since a submarine is not allowed to develop large angles in pitch or roll and, therefore, these angles can be linearized. However, there is considerable nonlinearity in the hydrodynamics, and at present there is not much information available concerning these nonlinearities. *Dr. James Follin* (Applied Physics Laboratory, John Hopkins University, Silver Spring, Md.) pointed out that one of the main differences between the submarine and the aircraft is the relative density of the body and the surrounding medium. However, the aerodynamic problem also has its share of nonlinearities. Dr. Pode added that another problem with submarine simulation is the wide speed range, since the submarine must be capable of operating down to zero speed.

Tremblay on Typhoon Simulator

This concluded the discussion period, so Hal Tremblay described the demonstration which he had prepared on the Typhoon simulator, a three-dimensional simulation of a representative aircraft requiring about 350 amplifiers. The output of this problem was put on a 21-inch scope which presented a two-dimensional picture looking from the tail of the aircraft. With this presentation, deviation from a straight-line path could be monitored well because the aircraft bank and return to the original flight path were easily observed.

The Typhoon simulator is impressive, consisting of about 58 nine-foot racks arranged in a "U" formation with two independent power supplies, either of which is capable of furnishing power for the entire computer. Part of the computer, it is interesting to note, has been designed specifically to solve the kinematics of three-dimensional problems.

SIMULATION COUNCIL



MEETING OF THE WESTERN SIMULATION COUNCIL

Approximately 32 assorted characters representing some 19 different organizations assembled at the Berkeley Scientific Division of Beckman Instruments Inc. in Richmond, California on the afternoon of 23 August for the regular September* meeting of the Western Simulation Council. After an inspection of the plant, where we saw the new models of the EASE computer, EPUT meters, etc. being assembled (and where in some cases the very female assemblers attracted more attention than the assemblies), we adjourned to the Don Hotel to discuss nonlinear servos, digital computers that work like analogs, and the design of an analog computer to minimize error.

Norman Irvine (Aerojet-General Corp., Azusa, Calif.) opened the discussion by asking *Dr. R. S. Neiswander* (Aerojet-General) to tell us something of his work with nonlinear systems.

*Sure and we on the West Coast are Eager Beavers all right, but the real reason the September meeting was held in August was to coincide with WESCON.

Neiswander on Nonlinear Systems

Dr. Neiswander made it clear at the outset that when you speak of optimizing a system you must define optimum, but if the system is nonlinear you must also define the input. And you must be very careful if there is more than one frequency in the input.

Phase-plane techniques are useful in working with second-order systems if the second-order term is consistent. However, the systems are more apt to be of higher order, and higher orders should be considered in nonlinear systems just as in linear ones.

To illustrate a comparison between a nonlinear and a linear servo, Dr. Neiswander considered the hot-rod driver who, having stopped for one red light, is anxious to get to the next red light in the shortest possible time. Therefore, when the first light goes green he applies maximum torque to accelerate as fast as possible until he has to jam on his brakes to stop at the next red light. Note that the driver has but one decision to make—he must determine the exact instant to change from full acceleration to full deceleration. Had he behaved like a linear servo, however, he would have had to make decisions continuously, and he would not have gotten to the next red light as soon. In the first case he was using the full capabilities of the system; in the second he was not.

Your Editor stated that he has a colleague at the Naval Air Missile Test Center (*E. Quimby Smith*) who claims that the best nonlinear servo is always better than the best linear servo, and asked: "Is that too strong a statement?"

Dr. Neiswander reiterated that the argument is that a linear system just doesn't use the full capabilities of the system.

Stan Rogers (Convair, San Diego, Calif.) said they had used diodes to give a multiplier servo high gain when the input signal was large. This resulted in a substantial improvement in the frequency response of the system.

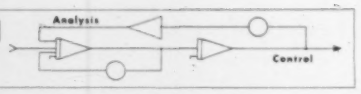
Norm next asked *Eli Anfenger* (Wang Laboratories, Inc., Cambridge 41, Mass.) to tell us about their WEDILOG computer.

Anfenger on the WEDILOG

Because Eli's introductory remarks paralleled Technical Bulletin No. 2 (available from Wang Labs), we will not go into detail here but just quote enough from that publication to give our readers an idea of what kind of a beastie we discussed.

"The WEDILOG Computer is an electronic digital differential analyzer. In a broad sense WEDILOG operates similarly to a dc analog computer. The major exception is that WEDILOG uses numbers instead of analog voltages to represent a variable. All the information in the computer is in the form of gate levels and pulses and therefore has the complete accuracy of a full-scale digital computer. All numbers within the machine are between the interval $\pm$ 1.00000 and are handled as an absolute value with sign. The computer is 'patched' in a similar manner as a dc analog computer.

"A separate register is designated for each variable of the problem and it is set with the proper initial con-



dition. . . . All variables are available simultaneously at all times.

"The computer consists of six types of computation units 'patched' together and operated from a Central Control: (a) Integrator Unit; (b) Adder Unit; (c) Distributor Unit; (d) Multiplier Unit; (e) Constant Multiplier Unit; (f) Multiple Factor Unit.

"The integrators indicate their values on neon lights.

"The computer may be stopped at any time to hold its value for typewriter tabulation or run continuously for a pen recorder.

"The principal advantages of the computer are its high resolution. It requires no precision power supplies and eliminates any measurements in the problem setup. All pre-set values are set in with rotary switches. As more comprehensive problems arise, computation units may be added without loading problems.

"The WEDILOG Computer will solve linear and non-linear, ordinary or partial differential equations, integral equations and simultaneous differential and algebraic equations. In addition, the computer can solve problems set up as matrices where data is to be corrected by fixed constants and manipulated by addition and/or multiplication."

In the discussion which followed Eli's description your Editor tried to get some idea of the speed of the WEDILOG, but only succeeded in a general way in establishing that: (1.) The speed depends on the nature of the problem. (2.) Like most DDA's it is too slow for most real-time simulation, and (3.) They are working in an attempt to increase the speed by a factor of 50.

Asked about the range of the dc voltage output, Eli said it was compatible with any commercial recorder.

Your Editor then wanted to know if Mr. Anfenger knew of any installation where the WEDILOG was made compatible and used with existing computer installations.

Eli said he thought the Laboratory for Electronics, Inc. (Boston, Mass.) had done this.

Stan Rogers asked about introducing arbitrary functions and was told it could be done with relays or tape; and in answer to *Joe Hussey* (Berkeley Scientific Div.) Eli said that an arbitrary function of the dependent variable could also be generated. They do not have equipment presently available for doing this, but they can make it.

Otis Updike (Naval Air Missile Test Center, Pt. Mugu, Calif.) wanted to know if the WEDILOG was related to the DART developed by the National Bureau of Standards at Corona a couple of years ago, but Eli was not able to say.

Asked about cost, Anfenger said that WEDILOG probably costs as much or slightly more than a quality electronic differential analyzer installation of equivalent capabilities, but costs considerably less than typical digital differential analyzers.*

*Otis told your Editor afterwards that cost information which he had was more favorable to the WEDILOG than Eli indicated, which again illustrates the danger of all generalities except the one that all generalities are dangerous.

The discussion of the WEDILOG was followed by a break, during which a caterer served refreshments (courtesy Berkeley Scientific) and everyone got a chance to bull with old friends and meet new ones.*

*We are sorry that these latter activities cannot be reported, because we suspect that sometimes—and possibly always—more knowledge is exchanged and more action stimulated during the break than during the longer discussions.

Hussey on High-precision Techniques

After the break, Norm asked *Joe Hussey* to tell us about the new EASE computer. Joe was the only one to speak on the announced subject of the meeting—"High-Precision Techniques."

Joe began by listing the various factors which contribute to the accuracy—or inaccuracy—of an analog computing system, and concluded that those which are most troublesome in the present state of the art are input information, human error, and nonlinear components: multipliers, resolvers, and function generators.

Joe admits he doesn't know what to do about the inaccuracies of input information, but in the design of the new EASE computer they have tried to minimize human error by the introduction of some pushbutton setup and by designing EASEy and accurate calibration methods.

As Joe says, "If you can make it convenient to calibrate you can actually approach the accuracy of the calibration system. If your amplifier shows 10% error, you can compensate by the pot setting." Joe said they also built a digital readout voltmeter to facilitate calibration.*

*When asked why he didn't use a digital computer, Joe replied, "Because I work for an analog manufacturer." Sound reasoning there, Joe!

He believes the optimum system will be one which will print out all pot settings at the push of a button. "Calibrating will not solve a problem, but given a bright engineer it makes for high accuracy!"**

**Or, as my boss Fred Sturm says, "If you have a good engineer you need good equipment. If you do not have a good engineer you've *got* to have good equipment."

INFORMATION (Without Theory)

We have several processes under consideration for our "Computer In Plant Project" announced last month, but no selection has been made yet and will not be until all aspects have been considered. We'll keep you informed!

This National Simulation Conference to be held in Dallas, 19-21 January, looks as if it will be quite interesting. We have a letter from *Louis Wadel* (3905 Centenary Dr., Dallas 25, Tex.) inviting the participation of all Simulation Councils and pointing out that it will be the first meeting of its kind * since the "Typhoon" Symposium in 1953.

We also have a letter from *Elmore Blanton* (DACL, MIT, Cambridge, Mass.) saying he is to organize a session on Physical Simulation. Now here is something your Editor can get his teeth into (though I might bite off more than I can chew). I have administered the development of a three-axis flight table for eight years now and watched other projects with interest. So when I read that Physical Simulation will include: (1) Use of actual system components together with analog or digital computers to

*He could have stopped right there. Certainly anything in Texas will be different! (Your Ed. is from New Orleans, so will refrain from saying how.)

analyze system performance; (2) Development of special equipment for physical simulation (flight tables, load simulators, etc.); (3) Evaluation of merits of physical simulation—this No. 3 seems like a *very* good subject!

* * *

Perhaps you have read our complaints about the Noise Generator problem in these columns. Well now there is an "Electronic Noise Generator Company" (our two sons are ruled out of the competition by that "Electronic"). Their product is being built and peddled by *Henry Low* and *Bob Bennett* (Ramo-Wooldridge, Los Angeles, Calif.) who were instrumental in the development of the prototype and a few copies while they were with Hughes Aircraft (with whose knowledge and consent they are now operating). The Hughes version seems to be well thought of.

* * *

We have a publication "DDA" by George Forbes that is over our heads because we don't know much* about digital differential analyzers, but if someone who does will give the word on it, we will send it to them and publish their review. Help, please.

* * *

Now we've seen it all—a *kit* computer—by Heath, of course. Our friend Chal Jones did the functional design—and we like it! Seems Chal drew on his years of experience and put himself in the user's position; result—a 15-amplifier, 30-pot, unstabilized (but with other advantages) computer for a proposed price (in kit form) of about $750.

* * *

The most interesting thing (to your Ed.) about WESCON was the emphasis of technical papers on nonlinear systems, and the most interesting exhibit at the ISA Show (probably to all interested in simulation) was the Leeds & Northrup nuclear reactor simulator. More about that in my article on conventions.

Your Editor has been told that since the *Newsletter* has been appearing on "slick paper" there are not so many "wise cracks." Alack! The "wiser" a man becomes, the fewer "cracks."

*Understatement of the month!

Thots

Doc Skramstad says the greatest contribution which digital-analog and analog-digital devices can make will be human, not technical; i.e., they will bring analog and digital people as well as machines together.

Chal Jones says that the greatest advantage of an analog computer is that for the first time it gives the engineer the advantage enjoyed by the doctor. With an analog computer an engineer can play his hunches and, by simply pulling patchcords on a stinkeroo, bury his mistakes.

Computer Events

other events on page 1584

Electronic Business Systems Conference
Date: 10-11 November 1955
Place: Hotel Statler, Los Angeles, Calif.
For information write Box 221, South Gate, Calif.

Western Simulation Council
Date: Thursday, 10 November 1955
Place: Beckman Instrument Co., Fullerton, Calif.
Subject: "Simulation with a Human in the System"

Eastern Joint Computer Conference
Dates: 7-9 November 1955
Place: Hotel Statler, Boston, Mass.
Subject: "Computers in Business and Industrial Systems". Chairman of the program committee, Dr. I. Travis, Burroughs Corp., Paoli, Penna.

Second Computer Clinic
Dates: 15-17 November 1955
Place: Navy Pier, Chicago, Ill.
Feature: Six 2-hour demonstrations and lectures on various computers. Fee is $5.00. For registration; 2nd Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Penna.

Western Simulation Council
Date: 12 January 1956
Place: Ramo-Wooldridge Corporation, 5740 Arbor Vitae, Los Angeles 45, Calif.
Time: 1300
Subject (tentative): Noise—Analog-digital combinations

Eastern Simulation Council
Date: Monday, 21 Nov. 1955; 1:30 PM
Place: Massachusetts Institute of Technology, DACL Laboratory, Cambridge 39, Mass. Host: Dr. William Siefert, DACL, MIT.
Subject: "The Use of Digital Computers in Solving Simulation Problems."

Midwestern Simulation Council
Date: Nov. 14, 1955
Place: St. Clair Hotel, Chicago, Ill.
Subject: "Patch Board Systems for Analog Computers."
Contact: R. R. Weber, Cincinnati Milling Machine Co., Cincinnati 9, Ohio.

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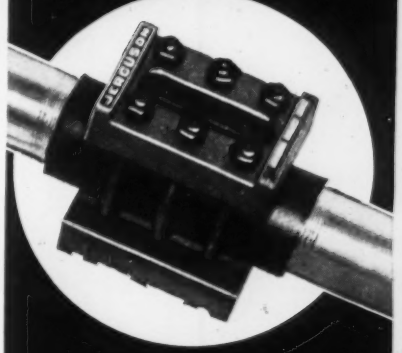

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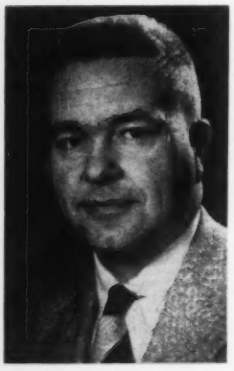
Introducing a new series on

DIGITAL AUTOMATION

THE AUTHORS

MARTIN L. KLEIN was born in 1924 in New York, N. Y. He has a B.S. in Physics from Penna. State University, an M.S. from Stanford University, and a Ph.D. (1950) from Boston University. He has taught Physics at Penn State, Stanford, and Pierce College; and worked for Whiting-Adams Corp. and the NAA, and is presently on the Engineering Staff of the Instrumentation Laboratory, Propulsion Field Lab, North American Aviation, Inc. He is a member of the IRE and AIEE.



FRANK K. WILLIAMS was born in 1914 in Sag Harbor, N. Y. He has a B.S. in Physics (1936) from Northwestern University, and has worked for Sciaky Bros. Inc., and North American Aviation. He is now supervisor of the Instrumentation Laboratory, Propulsion Field Laboratory, North American Aviation, Inc. He is a member of the IRE.

HARRY C. MORGAN was born in 1916 in Kalamazoo, Mich. He has a B.S. in Physics (1938) and an M.S. (1939) from Michigan State University. He has worked with Moraine Products Div. (G.M.), Monsanto Chemical Co., and is now Research Engineer in the Instrumentation Laboratory, Propulsion Field Laboratory, North American Aviation, Inc. He is a member of the APS and IRE.

AUTHORS' PREFACE

THIS series is designed to be a simple, practical, working design manual on the subject of Digital Automation. Although intended primarily for the instrument and electronics engineer, it is written at a level understandable to anyone engaged in the engineering and physical sciences. It is hoped that those on whom responsibility ultimately rests—management groups—find it of sufficient clarity to be read because only basic knowledge of electricity, electron tube circuits, and elementary mathematics through the calculus is required.

This material was developed largely in connection with a data-reduction program undertaken by the Instrument Laboratory of the North American Aviation, Inc., Propulsion Field Laboratory, Chatsworth, Calif. On completing this data-reduction system, it became evident that many of the techniques could be applied to servo systems and process-control systems.

The material was compiled also for a course entitled "Digital Automation" given at Pierce Junior College, Canoga Park, Calif., for practicing professional engineers and technicians. Although the course was nominally designed for electronics engineers, it was attended by engineers of all professions, personnel managers, and other management groups (to the surprise of the authors).

As this is the first exhaustive treatment of the subject, most of the material has never appeared in print. Several approaches are unique and original. Only time and widespread interest will determine if the approach taken is the optimum for the field.

It is customary to acknowledge the help given by many people in making a work such as this possible. In this instance the help was considerably more than cursory, and specific mention is in order. At North American Aviation, considerable impetus was given this program by Mr. Richard Loewe of the Marketing Division, who immediately saw the advantages and opportunities in Digital Control. Our immediate supervisor, Mr. Ed. Cartotto supported this project in every way. Considerable technical assistance was given by Mr. T. Barclay Thomson, who designed most of the Data Readout equipment, and Mr. Richard Rush, who developed several of the analog-digital conversion circuits. Mr. Aram Solomonian suffered the immensely difficult task of wiring the innumerable logical circuits, incredibly enough without error. Also, we thank our wives for making the coffee.

Martin L. Klein
Frank K. Williams
Harry C. Morgan

Chatsworth, California

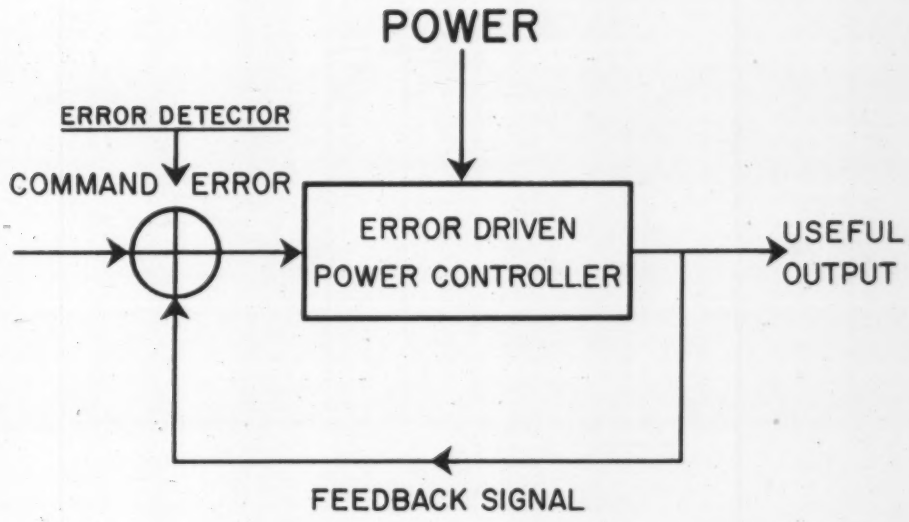


Fig. 1-1. Elements of a closed-loop feedback control system.

Definitions and Elements

Basic Definitions

This series presents the basic notions, methods, and systems used in Digital Automation. One is immediately confronted with the problem of defining the term "Digital Automation."

During the past few years, the word automation has been adopted to encompass any process where any degree of automaticity has been introduced. It is used in some industries in the broad sense of meaning any minute improvement in automatic technique (such as the substitution of printed circuitry for conventional point-to-point circuitry in the electronics industry). In the oil industry, where automatic control is common, it refers to automatic indication and control of, say, a refining operation.

A specific definition of automation, proposed by M. H. Aronson* in 1954, is "the substitution of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for human organs of decision and/or effort." In line with this definition, digital automation may be defined as the use of digital techniques in using automation devices for producing controlled decisions and/or efforts automatically.

The word "digital" is used in a restricted sense. It implies discreteness or discontinuity. Just as in the number system 0, 1, 2, etc., each digit is a mark for a discrete quantity of things, thus "digital automation" implies the control of processes using techniques in which the process is either (1) a series of discrete operations or (2) a continuous process controlled by the techniques of discrete quantities.

Conventional feedback control, which is a continuous monitoring of the output and comparison of the output with the input (Fig. 1-1), has become known as *servomechanism analysis* because most self-controllers are of this type. Digital techniques are perfectly applicable to all cases of continuous control, but the converse is not true.

Sequence Control

A significant application of digital systems lies in the field of sequence control. For example, let it be required that three different events take place in the sequence *b*, then *a*, then *c*. In a chemical plant the events could be (1) start burner to heat mixture, (2) when a certain temperature is reached, open valve to allow a chemical to enter, and (3) when a certain amount of chemical has entered the mixture, close valve and ring bell to show the sequence has been completed. It might be required that if the sequence of events does not take place as planned, the entire process be stopped and an alarm given. As an alternate, a second plan of action might be desired in the event the first failed. All of these situations are control of a *sequence of events.*

This type of problem suits itself simply to automatic control by digital techniques. The control of complex sequences and alternatives is simple by digital techniques; operations which could not be retained by the human mind because of their complexity are accomplished with a rapidity several hundred thousand times that capable by a human. Examples of important sequences are to be found in aircraft or missile control, operation of a turret lathe, or any process where the events to take place can be placed in a fixed sequence—with possible alternate sequences to account for things going wrong. Digital automation lends itself readily to this type of control.

Simple Servo Control

Another application of digital techniques is found in simple servo control. In a servo system, a command is given to a remotely actuated device. If for any reason the device does not arrive at the position required, or does not perform as commanded, a correction is made automatically. Remote antenna positioners or motor speed controllers are examples of simple servo systems in which the remotely actuated device continues in a self-correcting state until the error between the command given and the result of the command is minimized. This is the purpose of a servo system—to permit a system to correct its own errors in following remotely given commands. The value of the system depends upon the speed and precision with which the system can take up its own errors and follow the commands given.

It has been conventional to develop servo systems on the basis of an analog or continuous-recording technique. However, digital techniques are being recognized as useful in accomplishing the same type of control—with several distinct advantages which will be discussed.

*Editor, *Instruments and Automation.*

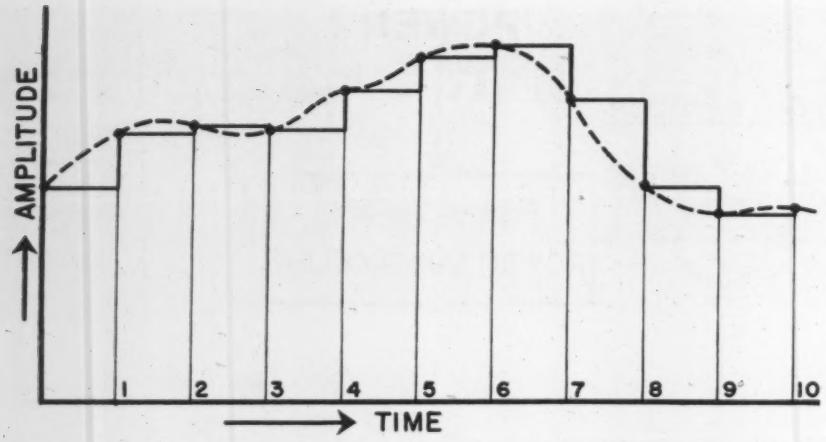


Fig. 1-2. Curve obtained by sampling at fixed intervals.

Data Reduction Systems

In the control of complex processes, data may be accumulated from hundreds of points. Usually these are recorded continuously, using a galvanometer or oscillographic or potentiometer techniques involving moving recording paper, inked pens, etc. Reducing this data for use becomes a tedious problem; wind tunnels are constantly confronted with the problem of reducing data from many points to numerical form for subsequent computation. The true automation system will not only control the process, but will also produce data in a form useful for automatic computation. This is within the realm of digital automation.

Data recorded in digital form can be processed directly by "programming." The result will be a printed number which is the answer required. Inventory, cost records, and production scheduling are within this realm of digital automation via data reduction. Business machinery in use for over twenty-five years operate exclusively in digital techniques; similar techniques can be applied to engineering data obtained in digital form. Business accounting is merely a special program for data handling; we shall borrow a number of well-developed techniques from this first and well-worked-out aspect of automation.

Feedback Control

All the foregoing aspects of automation are related; the common factor in all useful control systems is *feedback*. Feedback is accomplished by sensing in some manner what is happening to a system after a command is given. This measure of what is actually happening is compared with the command given the system. If these two quantities, command and output, do not agree, the system had made *an error* in following the command. This error is then used to allow the system to rectify its own error. This is controlled by feedback (Fig. 1-1). Note that it is not the command that actuates the system, but the *error* between the command and the result of the command. The ideal system is one which will instantly cause the system to move into the situation required by the command; this ideal can never be realized because the error must be finite.

Consider a human operator of a refinery process or a milling machine. If things progress properly he merely watches and does nothing. If something goes wrong, he recognizes the error, measures the degree of the error, and takes corrective action. From the automation point of view, this is complete inefficiency. When things are going right, you are paying the operator to do nothing; when something goes wrong you are relying on human judgment to measure the error and correct it.

Note also that a human operator is a feedback controller. First, he gives the commands as to what shall be done; secondly, he determines when the process is in error by referring to his gages and comparing the information with his command, mentally; thirdly, he takes the necessary corrective action by adjusting valves, motors, etc. to minimize the error. The operator is actually a feedback control system, but one whose limitations in speed, response, calculating, etc., are entirely human.

Elements for Automatic Control

The basic operations performed by the human operator are:

1. Command a device to perform a task.
2. Sense errors in the process.
3. Feed back this information and compare it with the command given.
4. Take corrective action to minimize this error.
5. Record data on the progress of the operations.

Each of these tasks can be done more rapidly and efficiently by mechanical, pneumatic, electrical, or electronic devices; design of an automation system depends on the application of such equipments to perform these basic actions.

Let us examine briefly the nature of the equipment to accomplish this. *Sensing* is accomplished with a transducer; there are innumerable commercial devices available. As electrical signals are most easily applicable to digital automation systems, we will concern ourselves with devices which produce an electrical signal. Pressure, temperature, displacement, velocity, acceleration, flow rate, force, angularity, and other variables can be measured in electrical form by suitable transducers.

This information in electrical form, is fed back and *comparison* is made with command given, which is also in electrical form. This comparison can be accomplished in several ways, such as by unbalancing a bridge or moving the shaft of a potentiometer to produce the electrical error signal.

This electrical error signal is used in suitable amplifiers, computers and other circuitry to *actuate* the devices (valves, motors, shafts) that make the corrective action minimizing the error. The same sensing element, (the transducer) can be used to *record* data on the progress of the process or operation. This is the automation system by feedback control.

It is possible to "control" a process without feedback—

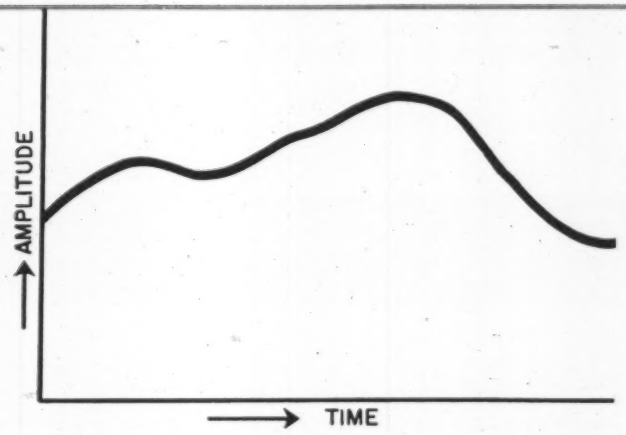


Fig. 1.-3. Continuous curve is analog representation of a variable.

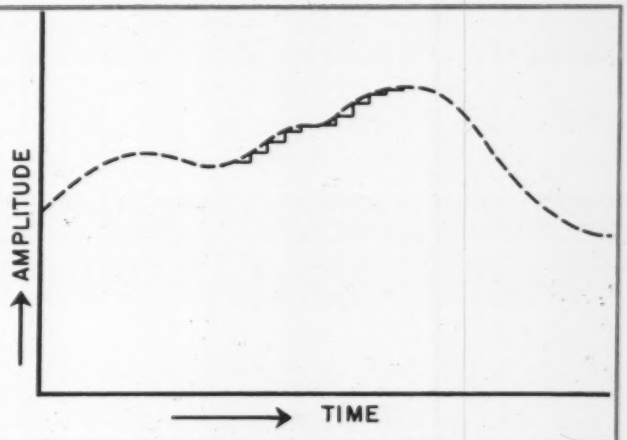


Fig. 1-4. Increasing number of readings causes digital record to approach the analog record.

that is, to arrange things to occur in certain order without sensing what is actually happening; things might occur properly. This is known as *open-loop control*, and is actually no control at all; it is hardly worth considering as an automation technique. Thus, each of the five elements listed are essential in the true control system.

Continuous vs. Digital Control

There are two possible ways to make use of the electrical information. Fig. 1-3 shows a continuous record of electrical information from, say, a pressure transducer. This continuous curve is a type of information widely used in conventional servo systems and simple control systems.

Fig. 1-2 is the same record shown in discrete, or digital, form. In this record we have looked at the continuous record at fixed intervals. Each sample is taken to represent the continuous record until the next sample is obtained. We have effectively changed the continuous record into a finite number of fixed readings. This is equivalent to having someone read a graph at fixed intervals and record the numerical value at these fixed intervals, and thus *digitize* or *quantize* the continuous record.

At first sight it would seem that control is best offered by continuously recording what is happening and thereby knowing at every instant exactly what is occurring. However, in using a continuous record, one limits himself seriously insofar as automatic control techniques because the analog record precludes digital technique. Note that if samples are taken sufficiently often (as in Fig. 1-4) the continuous record can be more and more closely approximated. In effect, the discrete readings can be made to be equivalent in accuracy to the continuous record—and the advantage in using the digital form of record is that digital numbers can be manipulated electronically much more simply than the analog record. The advantages of such digital techniques will be explored.

Digital techniques of control are just emerging; automatic digital data reduction has only been commercially available for a limited time. Therefore, we will, in essence, develop a considerable number of methods for the first time.

The most common system used in computer circuitry is the binary coding system, which we will investigate. This subject should be of interest to almost everyone, and is largely ignored. As the circuitry of digital information is unique, the performance of the basic circuits will be discussed in detail. What is surprising is that the *number* of different circuits used is small; only ten or twelve basic circuits are used over and over. This is a great help.

Automation is essentially a process of logic, and *logical networks* form a large part of the operation of a digital control system, as in computers. An understanding of the methods for designing these circuits is necessary and will be included.

It was mentioned that the digital samples approach the continuous record more and more closely as the sampling rate increases. It is necessary to know what error, if any, is introduced in using digital quantities instead of continuous records. This falls under the heading of *information theory*. In the chapter concerned with sampling rates, a fairly simple and straight-forward explanation is offered and quantitative examples are included for guidance. We will be concerned also with the interference of random and spurious noise on the information to be used for the control, and the advantages of using what is known as *pulse code modulation* for relaying information from one point to another.

Consideration will be given also to automatic data reduction. By using recording instruments such as a tape recorder or shutterless motion-picture camera, the techniques discussed can be adapted to recording data in digital form. It will be shown also how the digital data obtained from either the recorder or the computing machine can be automatically converted back into continuous or analog form so that, if desired, analog traces can be obtained at any time.

Quantization and Computers

Use of digital techniques may at first seem unnatural; this should not be so. Although we study continuous phenomena at elementary levels in physics and mathematics, we find as we progress in our studies that the universe is a quantized universe; thus quantum mechanics.

Human reasoning and logical processes are often likened to the operations taking place in a digital computer. This has led to a certain confusion and belief that a digital computer or an automation system is a "thinking mechanism." This is not true. Computers and automation systems are slaves of the program which has been designed for them; they are unable to perform any thinking operations that have not been previously thought out for them; they can exert no reflex actions, cannot learn from experience, cannot inject opinion. As we shall see, this is to the advantage of automatic control over control by human operators where human forces are constantly at work to disrupt the logical processes. The machine can perform its operations faster than the human being, but it is always and inevitably the slave of its master.

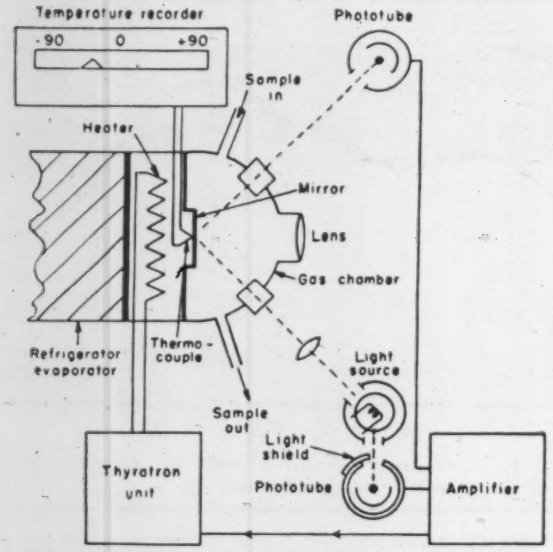


Fig. 1. Dew-point recorder of chilled-mirror type. Moisture from atmosphere to be controlled condenses on chilled mirror, and is detected photoelectrically. Signal energizes heater element to evaporate moisture. Equilibrium temperature is dew point. (Courtesy General Electric Co.)

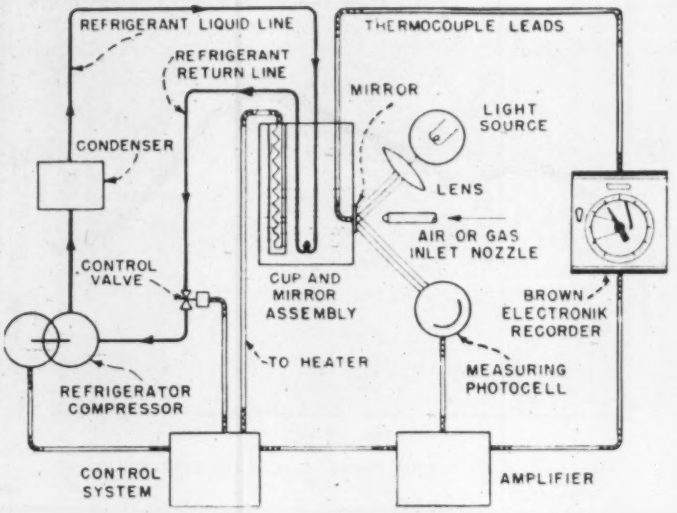


Fig. 2. Dew-point recorder-controller of chilled-mirror type, using the same principle as that shown in Fig. 1. (Courtesy Surface Combustion Corp.)

Furnace-Atmosphere Control by

Heat treatment of steel requires control of furnace atmosphere. This can be done via control of either CO_2 or dew point (water content). The latter permits closer control of the atmosphere. Techniques for control by dew point include (1) dew-point cup, (2) moisture condensation on cooled mirror or metallic surface, (3) formation of fog on sudden expansion of gas, and (4) conductivity of hygroscopic-salt element. Also mentioned are several non-dew-point techniques for atmosphere control.

UNTIL recent years the heat treatment of alloy steel dies was somewhat of an art. Results would vary from day to day, and from tool to tool. However, with the development of efficient electric furnaces, gas-fired retort-type furnaces, and controlled manufactured atmospheres, the heat treatment of steel has become an exact science.

Importance of Furnace Atmosphere

Whenever steel is heated, it becomes chemically active with the atmosphere in the furnace. Above 1300°F, this action of the furnace atmosphere may damage the surface of the steel by causing scaling by oxidation or change in surface carbon by carburization or decarburization.

Hardening a tool to a desired specification requires good control of the furnace atmosphere because a decarburized tool or machine part will not have the mechanical properties for which it was designed.

One of the more popular types of controlled atmospheres for the heat treatment of tools and dies is that produced by the endothermic-type generator (which will be described later). Investigators working on the reactions involved in the endothermic-type atmosphere have established that the "carbon potential" of the atmosphere can be determined by measuring either the CO_2 or the H_2O (dew point) of the atmosphere. Cullen[5] found that the carbon range in steel specimens was much closer when the furnace atmosphere was controlled by measuring the water content (dew point) rather than the CO_2 content (by Orsat). Therefore, techniques for measurement and control of the dew point of the furnace atmosphere assume special importance. Details on the furnace reaction will be given after a review of instrumental methods available for measurement and control of the dew point of the furnace atmosphere.

Classic Dew-point Cup

The sample of atmosphere is drawn from the furnace by a small pump, either electric or hand operated, or

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, 1955.

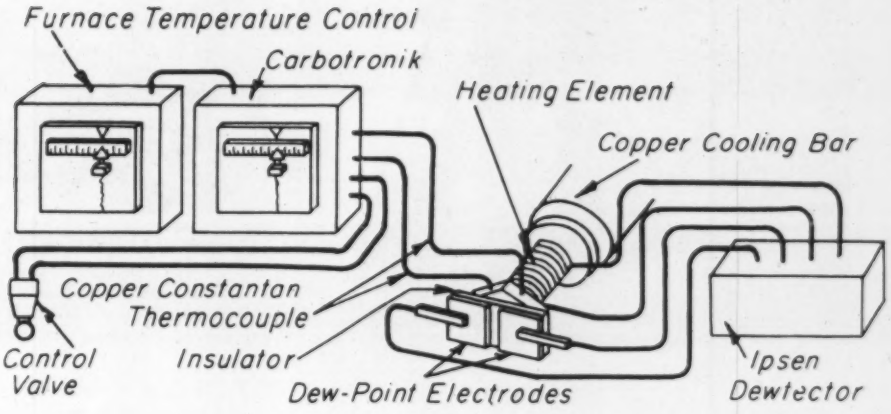


Fig. 3. Dew-point recorder-controller using condensation in gap between two platinum electrodes to close circuit. Heater element then evaporates moisture. Dew point is equilibrium temperature. (Courtesy Ipsen Industries, Inc.)

F. E. SLATER, Aluminum Company of America

DEW-POINT CONTROL

TERMS USED

Dew Point: Temperature at which condensation of moisture from the atmosphere begins.

Carburization: Addition of carbon to the surface of tool steel.

Decarburization: Removal of carbon from the surface of steel.

Endothermic Process: Reaction involving absorption of heat.

Carbon Potential of furnace atmosphere. Carbon balance of furnace atmosphere in relation to the carbon content of steel being treated. Sometimes referred to as "carbon pressure."

aspirator bulb. The sample passes over the outside surfaces of a hollow, polished, nickel-plated cup, which is enclosed in a small metal box having a window on one side for observing the formation of moisture on the cup.

The cup is cooled with dry ice (CO_2 snow) dissolved in acetone, which is contained in the cup. A thermometer in contact with the cooled acetone in the cup indicates the temperature of the solution. The temperature read the moment moisture appears on the cup is the dew point of the atmosphere. The operation is visual. The accuracy of the reading varies with the skill and experience of the operator taking the reading.

Condensation of Moisture on a Cooled Mirror or Metallic Surface

At present, at least three instruments are available which operate on the principle of condensation of moisture from the atmosphere on a chilled mirror or metallic surface. A choice of instruments is available for indicating, recording or controlling the furnace dew-point. The units may be fixed or portable, and mechanically or manually operated.

Chilled Mirror Type

Briefly, a sample of gas is taken from the furnace and passed onto a mirror which is being cooled by a refrigerant. The chilled mirror causes a fog (condensation of moisture in the sample) to form on the mirror, reducing the intensity of the reflected light from the mirror, which is measured by a photoelectric tube.

The change in light intensity energizes electronic controls, which causes the mirror temperature to be recorded as dew point at the moment fog appears on the mirror. Heater elements are used to evaporate the moisture from the mirror. The instrument is then ready for another reading. Figs. 1 and 2 show this type.

Chilled Metal Surface

In another type of dew-point instrument (Fig. 3) a sample of atmosphere is drawn from the furnace and directed onto two platinum electrodes mounted at one end

Fig. 4. Alnor "Dew-Pointer" uses principle of fog formation on sudden expansion of atmosphere. Expansion cools sample; mist forms if sample is cooled below the dew point. Procedure is repeated using different gas ratios (ratio of atmospheric pressure to sample pressure) to find point between formation of mist and no mist. Calculator then gives dew point. (Courtesy Illinois Testing Laboratories, Inc.)

of a copper cooling unit. As the gas sample strikes the electrodes (which are being cooled by the refrigerant), condensed moisture forms in the gap between the electrodes and completes the circuit. At this moment, the temperature of the electrodes is measured and recorded as dew point. Also, a sensitive relay energizes the heater around the cooling unit, which warms the electrodes to evaporate the moisture. The unit then is ready for another dew-point determination.

Instruments of this type are available to automatically record and control the dew point (or % carbon) of the furnace atmospheres.

Formation of Fog on Sudden Expansion of Compressed Gas

A unit operating on the principle of the formation of fog by sudden expansion of a compressed gas is shown in Fig. 4.

A gas sample is drawn from the furnace by an integral double-acting hand pump, and compressed. A hand-operated valve releases the compressed gas into the observation chamber. A sudden expansion to atmospheric pressure cools the gas sample. If the sample is cooled below its dew point, a mist cloud will be observed in the chamber. This procedure is repeated, using different pressure ratios (ratio of atmospheric pressure over the pressure of gas sample) until the vanishing point (end point) is determined—that is, a point between the formation of mist and no mist.

The dew point is read from a calculator based on instrument temperature, pressure ratio of end point, and Q value (cooling power) of the gas.

Dew Point by Hygroscopic Salts

Another type of instrument for dew-point measurement is based on the behavior of a hygroscopic salt in the presence of moisture.

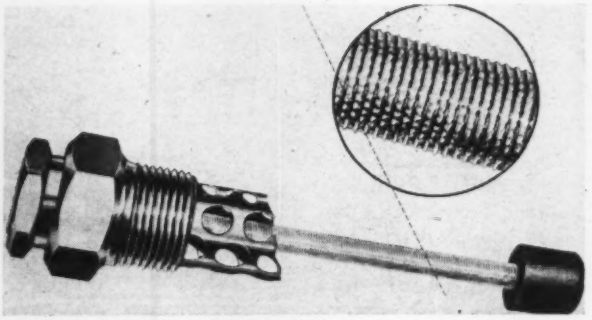


Fig. 5. "Dewcel" element uses gold or silver wires wound on woven-glass tape impregnated with hygroscopic salt (lithium chloride). Conductivity of assembly depends on moisture content of atmosphere. (Courtesy The Foxboro Co.)

In one such instrument (Fig. 5) the sensitive unit consists of a thermometer bulb inside a stainless-steel tube which is covered with a woven-glass tape impregnated with lithium-chloride salt. A pair of gold or silver wires are wound over the glass tape. One end of each of the pair is connected to a source of a-c power, the other end of each wire being left open.

The atmosphere sample is taken from the furnace and drawn over the sensitive unit, which is contained in an air-tight chamber. The conductivity of the assembly increases or decreases according to the moisture content of the atmosphere sample. This change in conductivity causes the current to change until an equilibrium temperature is obtained; the dew point of the atmosphere is a function of this equilibrium temperature.

For accurate measurement, the temperature of the atmosphere sample must be below the equilibrium temperature of the sensitive unit, but above the dew point. This instrument is automatic and available for indicating, recording, or controlling dew point.

Another available instrument, also using a hygroscopic salt, consists of metallic windings on a plastic core impregnated with lithium chloride. A measurement of the electrical resistance between the windings can be interpreted in terms of dew point. Up to the time of this writing, no additional information on this instrument had been received.

Non-dew-point Technique

There is another method available for controlling furnace atmospheres which should be mentioned even though not based on measurement of dew point. This method uses the principle of exposing a wire element in a furnace atmosphere and measuring the carbon potential of the furnace atmosphere by measuring changes in the resistance of the wire.

The carbon content of the wire changes as the carbon potential of the furnace atmosphere changes, which in turn changes the wire resistance. The resistance of the element is measured as percent carbon on a recorder.

Up to the present, the use of this instrument is restricted to the manufacturer's furnaces and for temperatures up to 1750°F.

Another available instrument exposes a steel wire in a sample of furnace atmosphere until a carbon equilibrium is attained between the hot wire and the atmosphere sample. The wire is suddenly cooled to retain the carbon in a martensitic structure. A measurement of the electrical resistance of the wire can be interpreted in terms of the carbon potential of the furnace atmosphere by reference to a calibration curve. It is a portable instrument.

It should be mentioned also that quantitative gas analyzers and infrared analyzers are available for measuring and controlling gases in a furnace atmosphere.

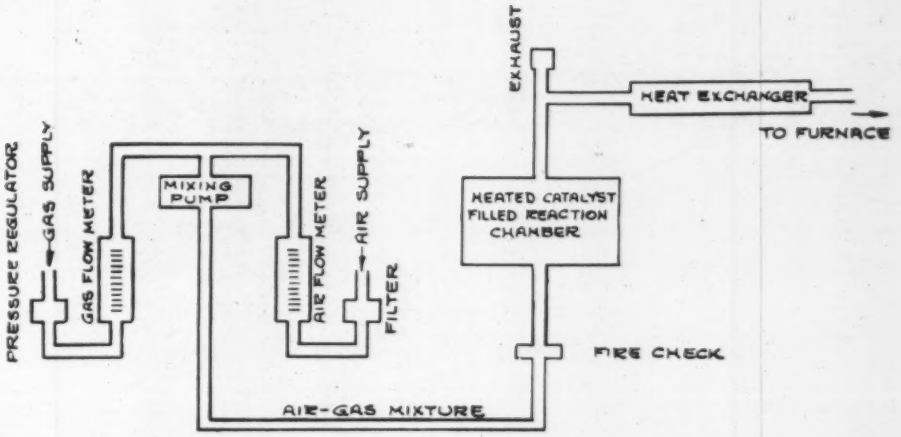


Fig. 6. Typical endothermic generator. Air-gas mixture is reacted in heated catalyst chamber to form an atmosphere with 40% H_2, 20% CO, 39% N_2, and traces of CH_4, CO_2, and H_2O.

Precautions Necessary For Dew-point Readings

Experience indicates that the use of dew point appears to be the easiest method of evaluating and controlling furnace atmosphere. Good furnace-maintenance, heat-treating, and atmosphere-sampling procedures must be practiced to have satisfactory results. These include:

1. The furnaces must be kept in good repair. The door should have a tight fit. As dew point will vary with temperature, it is important to control the furnace temperature. Any excess carbon deposits on the hearth and refractory walls should be removed. This carbon will change the carbon potential of the atmosphere and upset dew-point control.
2. A heat-resistant alloy should be used for the sampling tube. The atmosphere sample should not be taken near the door or atmosphere inlet. The atmosphere sample should be representative of the atmosphere surrounding the work. The tube should extend through the furnace wall an inch or two.
3. Allow time for the sampling lines and instrument to be purged of moisture before taking a reading.
4. A second dew-point instrument should be available for cross checking and for locating sources of trouble at the furnace, sampling lines, atmosphere inlet lines, or generator.
5. The instructions supplied with the dew-point equipment should be carefully read, understood, and followed.

Endothermic Type of Generated Furnace Atmosphere

As was mentioned, one of the more popular types of controlled atmospheres for the heat treatment of tools and dies is produced by the endothermic type of generator.

As shown in Fig. 6, the endothermic type of atmosphere is produced by passing a measured volume of filtered air and raw gas through a heated catalyst-filled reaction chamber. This reaction chamber may be heated either by electricity or by gas. After the gas passes over the catalyst bed, it is cooled to approximately room temperature to prevent the reaction from reversing and forming carbon and carbon dioxide from the carbon monoxide. The reacted gas is then ready for distribution. This endothermic type of prepared atmosphere contains approximately 40% H_2, 20% CO, 39% N_2, and small amounts of CH_4, CO_2, and H_2O.

Chemical Reactions For Control of Furnace Atmosphere

It is beyond the scope of this paper to discuss in detail the chemical reactions involved in working with the endothermic type of reacted furnace atmospheres. Investigators [1, 2, 3, 4] working on the reactions involved in the endothermic type of furnace atmosphere have established that these reactions follow basic laws of physical chemistry and thermodynamics.

Whenever a ferrous material is heated in the presence of an atmosphere containing oxygen, an iron oxide is formed. These reactions go to completion as long as oxygen is present:

$$2\,Fe + O_2 \rightarrow 2\,FeO$$
$$4\,FeO + O_2 \rightarrow 2\,Fe_2O_3$$
$$3\,Fe + 2O_2 \rightarrow Fe_3O_4$$

The following equations show the reaction of carbon dioxide with iron, but are reversible and can be controlled as to rate and limit at definite temperature:

$$Fe + CO_2 \rightleftarrows FeO + CO$$
$$3FeO + CO_2 \rightleftarrows Fe_3O_4 + CO$$

Water vapor reacts with iron according to the following equations. These reactions may be oxidizing or reducing according to concentration and temperature:

$$H_2O + Fe \rightleftarrows H_2 + FeO$$
$$H_2O + 3\,FeO \rightleftarrows H_2 + Fe_3O_4$$

The following reactions affect the carburization or decarburization rates of the heated tool:

$$3\,Fe + 2\,CO \rightleftarrows Fe_3C + CO_2$$
$$3\,Fe + CH_4 \rightleftarrows Fe_3C + H_2$$

These reactions are reversible and can be controlled. The formation of C from the breakdown of CO and CH_4 in the above reactions exerts a carbon potential in a relationship to the concentration of CO, CO_2, H_2 and CH_4 at definite temperatures.

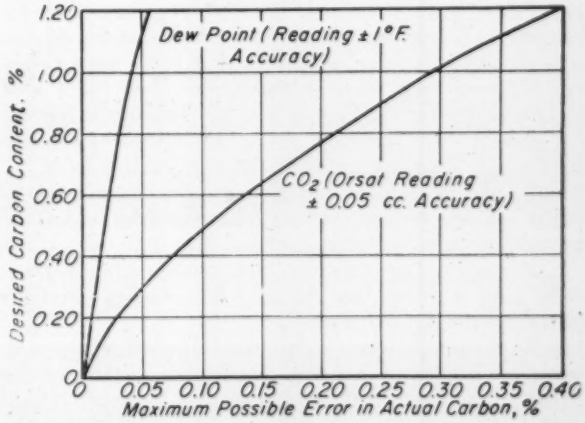


Fig. 7. Limits of accuracy in controlling carbon by dew point vs CO_2 determination. Atmosphere is 20% CO, 40% H_2 & 40% N_2 at 1700°F. (Courtesy O. E. Cullen from METAL PROGRESS, November, 1954.

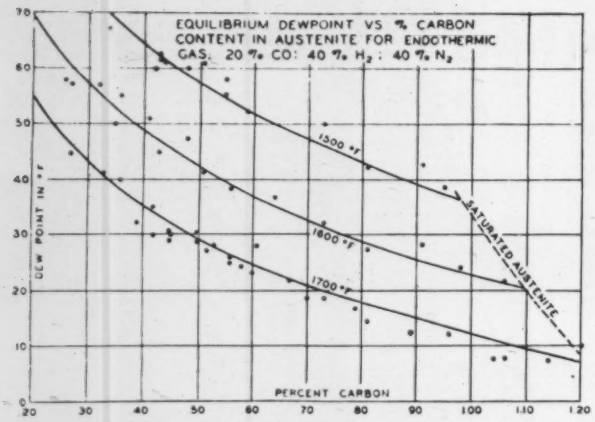

EQUILIBRIUM DEWPOINT VS % CARBON CONTENT IN AUSTENITE FOR ENDOTHERMIC GAS. 20 % CO: 40 % H_2 : 40 % N_2
DEW POINT IN °F
PERCENT CARBON
1500 °F
1600 °F
1700 °F
SATURATED AUSTENITE

Fig. 8. Equilibrium between dew point of endothermic gas (20% CO, 40% H_2 and 40% N_2) and percent of carbon content in austenite at temperatures of 1500, 1600, and 1700°F. (Courtesy O. E. Cullen from METAL PROGRESS, December, 1953.)

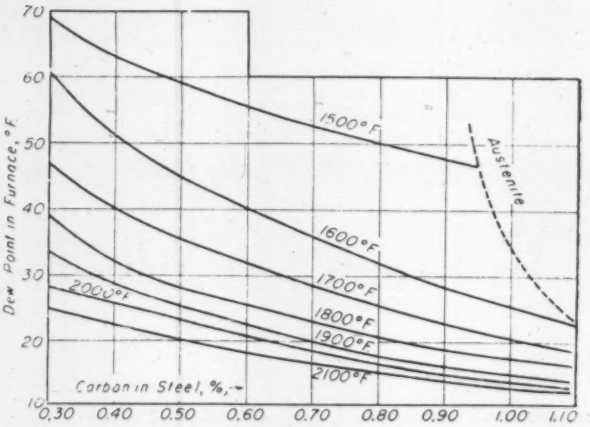


Fig. 9. Equilibrium between straight carbon steels and dew point with endothermic furnace atmosphere. (Courtesy N. K. Koebel from METAL PROGRESS, November, 1954.)

The following reaction, which is basic for the evaluation and control of furnace atmosphere by dew point, is known as the *water-gas reaction*. When using the gas contained in this reaction, it is important to understand that its composition within the furnace will vary with furnace temperature.

$$CO + H_2O = CO_2 + H_2$$

The above equation may be expressed as the ratio:

$$\frac{CO \times H_2O}{CO_2 \times H_2} = K \text{ (constant at a given temperature)}.$$

As shown by Groves[3] the relationship of the ratios of CO/CO_2 and H_2O/H_2 makes is possible to determine the carbon potential of an endothermic-reacted furnace atmosphere by checking either the CO_2 or H_2O (dew point).

Cullen[5] found that the carbon range in steel specimens was much closer when the furnace atmosphere was controlled by measuring H_2O content (dew point) rather than by CO_2 (Orsat). This is shown by the curves in Fig. 7.

Equilibrium Curves Between Temperature and Carbon Content of Steels

Intensive investigations have been conducted on the variation in carbon content with temperature. Two investigators, Cullen[5] and Koebel[7], working independently, have published a series of curves that show the equilibrium between the furnace-atmosphere dew point and straight carbon steel (Figs. 8 and 9). This work has led to a present understanding of the importance of controlling furnace atmosphere during the heat-treating cycle.

The work by Koebel and Cullen provides the metallurgist and heat treater with the following information for the heat treatment of plain carbon steel:

1. For any constant temperature, as the carbon content of the steel increases, the required furnace dew-point for neutral hardening is lower.

2. As the temperature is increased, lower furnace dew-points are needed to maintain the original carbon on the surface of the steel. As the temperature is increased, closer control of furnace dew-point is required.

3. The curves serve as a guide for determining the probable furnace dew-point for neutral hardening and the carburization processes which include carbon restoration. (Carbon restoration is the process of adding carbon to a surface of steel products made from bars containing decarburized millbark, providing a uniform carbon content from surface to core.)

4. The results of production work treated in industrial furnaces will vary slightly from the calculated curves, since it is almost impossible to maintain a true equilibrium in the furnace. This condition may vary from furnace to furnace and from plant to plant. This disagreement should not be a problem because of the information contained in the curves and given in references 5 and 7.

The equilibrium curves for plain carbon steels do not apply to the treatment of alloy steels because the alloy composition of the steel affects the rate of decarburization, carburization, and oxidation (scaling of surface). Anyone interested in this work should refer to the series of equilibrium curves for a number of alloy steels developed by Koebel[7].

Acknowledgment

The author appreciates the courtesy to use material published by Mr. O. E. Cullen of Surface Combustion Corporation, and Dr. N. K. Koebel of Lindberg Engineering Company, and for detailed information on dew-point instruments from The Foxboro Company; General Electric Company; Illinois Testing Laboratories, Incorporated; Ipsen Industries, Incorporated; Leeds & Northrup Company; Surface Combustion Corporation; and Westinghouse Electric Corp.

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7. N. K. Koebel, "Equilibrium Relationships For Dew Point Control," *Metal Progress*, November, 1954, page 110.
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ELECTRONIC CIRCUITRY

CHARLES F. KEZER and MILTON H. ARONSON

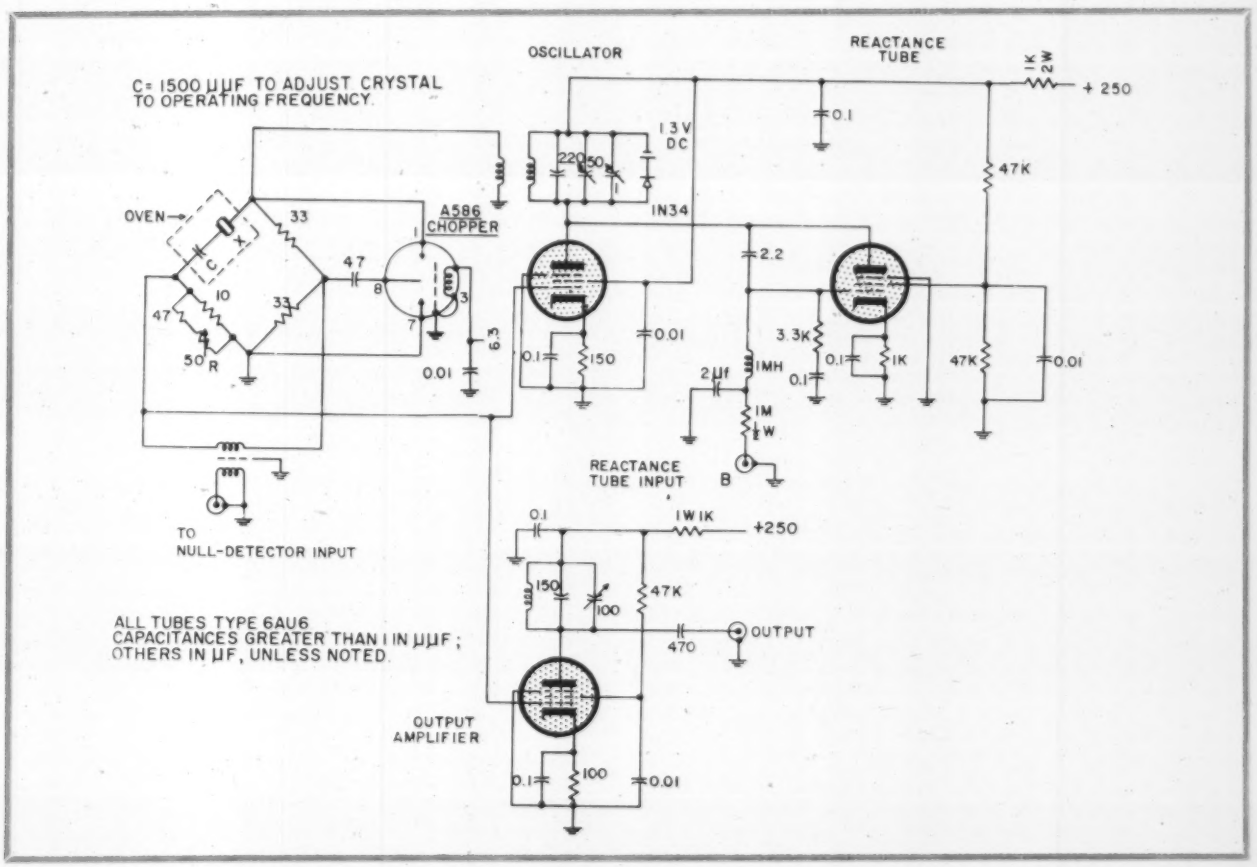
The circuit is the heart of all electronics. Here are five more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

PORTABLE SECONDARY 1-MC FREQUENCY STANDARD

Frequency of this oscillator, developed at the National Bureau of Standards, is constant to a few parts in 10 billion per day. Frequency is almost independent of tube, supply, and component changes. This unusual stability is obtained by close temperature control (see next circuit) and a novel circuit in which the 1-Mc AT-cut crystal does double duty as the oscillator tank circuit and as the frequency-determining element of a low-impedance resonance bridge.

Frequency of the oscillator is controllable over a small range by a reactance tube. Reactance tube is controlled by a null detector-amplifier (shown in following circuit) to match oscillator frequency to the crystal. In this way, oscillator stability is made to approach that of the crystal, which would otherwise be impossible because of random phase-shift changes in the oscillator circuitry.

The crystal bridge is normally balanced to have minimum (near zero) output at the series-resonant frequency of the crystal. If the oscillator frequency is off the correct value, output of the bridge will increase. This increased voltage is amplified and detected in the null detector-amplifier; it is also necessary, however, to detect whether the frequency is high or low. This is done with the chopper, which alternately shifts the bridge balance frequency up-



ward and downward at a 60-cps rate by connecting the 47-uuf capacitor across the resistive arms of the bridge. This switching has negligible effect on oscillator frequency, as oscillator output is at low impedance. When oscillator frequency is correct, bridge output is the same for either position of chopper contact. Difference in outputs is detected in the auxiliary null detector-amplifier (described in following circuit) which uses a synchronously driven chopper, and which controls the reactance tube shown in this circuit. Buffer amplifier shown at bottom provides output.

Tubes: All 6AU6

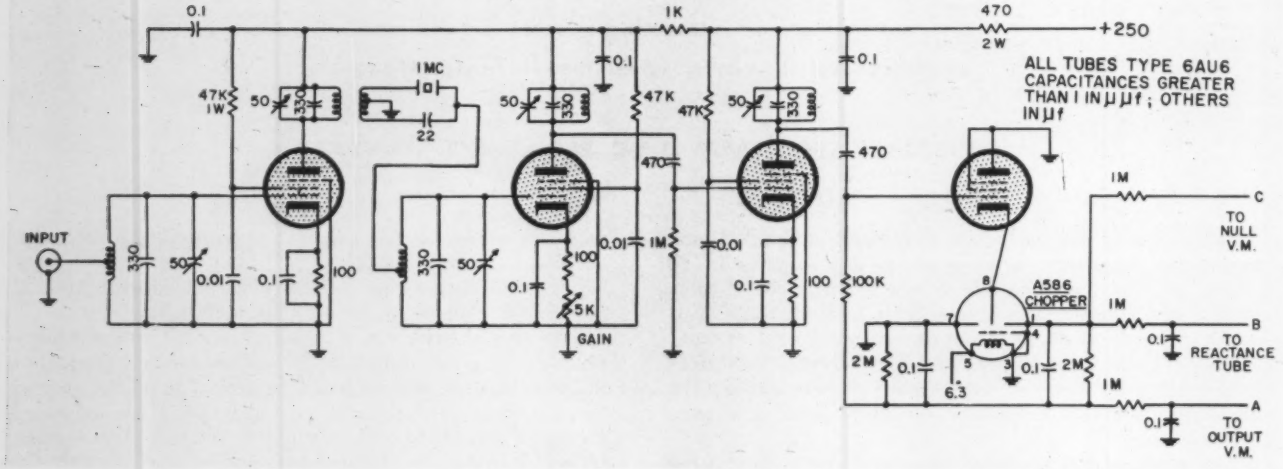
Crystal: 1-Mc AT-cut; resistance = 10 ohms; Q = 10^6.

Bridge arms: 2500 ohms (each) at 50° C.

B supply: 250 v (VR-tube regulated) at 105 ma. Same supply is used for following circuits.

Source: Peter G. Sulzer, NBS, Washington 25, D. C., as described in TR 1924, June, 1955.

1-MC NULL AMPLIFIER AND DETECTOR



This amplifier-detector circuit was developed for use with the 1-Mc oscillator shown in the preceding circuit. It uses four 6AU6 pentodes. Three tuned-amplifier stages provide a voltage gain of 10^7; a crystal filter between first and second stages provides additional selectivity. The fourth 6AU6 tube is diode connected; it is switched by a chopper to charge alternately the two 0.1-uf capacitors connected to its contacts. If the frequency of the 1-Mc oscillator in the preceding circuit is correct, these capacitors will be charged equally, and the voltage output to the reactance tube at point B will be zero. If oscillator frequency is off, a 60-cps modulation of the 1-Mc carrier will be present, and one of the two capacitors will be charged to a higher potential than the other, and an error voltage will be developed at point B. Polarity of this voltage depends on whether oscillator frequency is high or low because the chopper is driven in synchronism with the chopper in the preceding oscillator circuit.

Charging of the detector capacitors is as follows: When the chopper contact is in the left position, diode cathode is grounded, and the 470-uuf coupling capacitor charges to the negative peak of the 1-Mc voltage. After a number of cycles (circuit need not respond rapidly) this negative potential charges the left 0.1-uf capacitor to an equal level. When the chopper arm is in the right-hand position, the right-hand 0.1-uf capacitor is charged through the diode on positive peaks of the 1-Mc carrier. Ultimately it reaches the peak value of the 1-Mc voltage. No charging of the left-hand 0.1-uf capacitor takes place during this time because it is at r-f ground potential.

As the two 0.1-uf capacitors are in series with respect to output B, their voltage difference appears at this point. Filtered output is provided by the 1-megohm resistor and 0.1-uf capacitor combination to remove any remaining r-f components.

B supply: 250 v, VR-tube regulated.

Source: Peter G. Sulzer, NBS, Washington 25, D. C., also TR 1924, June, 1955.

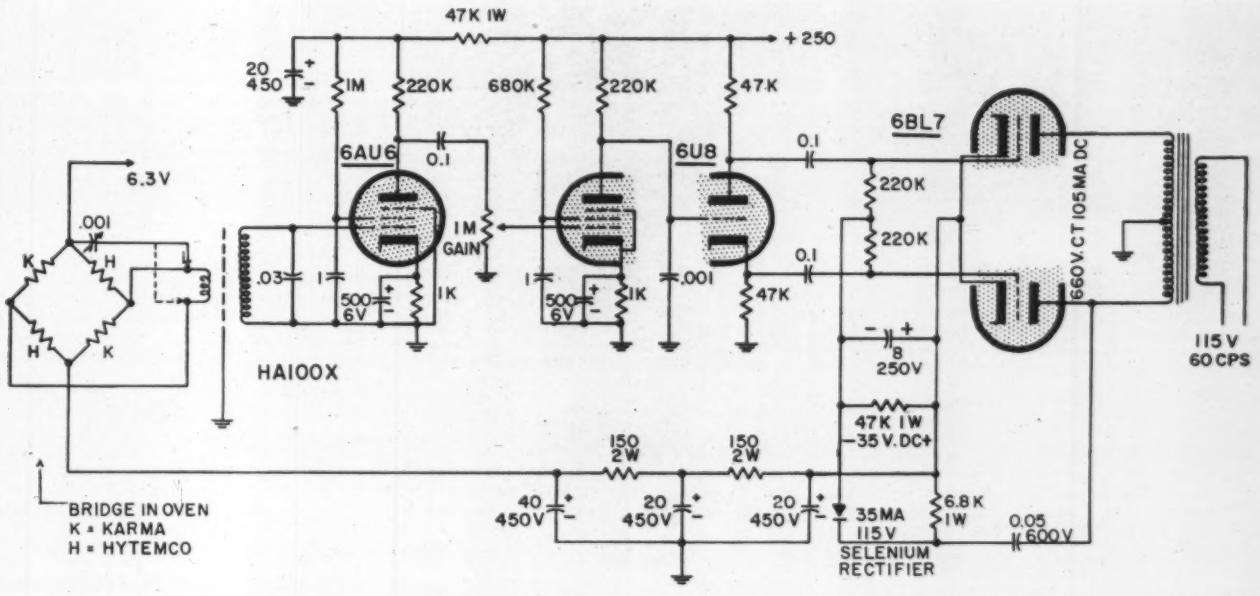
TEMPERATURE CONTROLLER CONTROLS WITHIN 0.001°C

This temperature controller circuit was designed at the NBS for controlling the temperature of an enclosure containing the frequency-controlling crystal bridge shown in the previous circuit. Temperature is controlled within 0.001° for an ambient change outside the enclosure of 22 C°.

The temperature-sensitive element is the bridge containing two temperature-sensitive arms and two non-temperature-sensitive resistors. It also is the heating element for the enclosure. The bridge is wound on the walls of the enclosure.

The bridge is heated from a d-c source which establishes the balance temperature. A small 6.3-v 60-cycle signal also is supplied to the top of the bridge. If the bridge temperature deviates from the desired balance temperature, a 60-cycle signal appears at the input to the amplifier. This signal is amplified and applied to the 6BL7 phase-sensitive rectifier.

The phase of the output signal from the bridge depends on whether the temperature deviation is positive or negative. Phase sensitivity is established by the 6BL7 as follows: Grids of the 6BL7 rectifier are driven in phase-opposition by the triode section of the 6U8, connected as a split-load phase inverter. Plates are energized also in phase opposition by 60-cps transformer. When bridge temperature is low, error voltage at 6BL7 grids is in-phase with corresponding plates, producing increased rectified output (from cathodes) to the bridge. This in turn provides increased heating. When bridge temperature is high, error voltage at 6BL7 grids is out of phase with



the corresponding plates, and rectified output is decreased.

Selenium rectifier provides —35 v dc bias for 6BL7; the rectifying a-c voltage is obtained through the 0.05-uf coupling capacitor to transformer secondary.

B supply: 250 v, VR-tube regulated.

Source: Peter G. Sulzer, NBS, Washington, D. C., as reported in TR 1924, June, 1955.

HIGH-IMPEDANCE VTVM

Developed for measurement of cathode impedance of tubes, this peak-reading VTVM must have high input-impedance in order not to disturb the circuits under test. Input impedance is sufficiently high that a 10-megohm resistor placed in series with the input causes only a 1-percent error in reading the peak voltage of a 60-cps sine wave. Circuit normally is used to read peak values of pulses recurring at 60-cps rate, but can be used under other conditions, including d-c-voltage measurement.

Input half of the first 6SL7 conducts during the positive-going input pulse, charging the storage capacitor C_1, which slowly leaks its charge through 1 Meg resistor. Right-hand half of the first 6SL7 provides a balance for the quiescent voltage across this resistor. Second 6SL7 is current amplifier which drives the indicator movement.

The scale is nonlinear below 1 volt; correct linear scales on the 10- and 20-volt ranges are achieved by selection of R_{18} and R_{19}, which apply zero offset voltage to the final stage. No offset is provided for higher ranges as the error is considered negligible at higher ranges. Insertion of this zero offset causes a corresponding error in reading d-c voltages.

B supply: 300 v at 150 ma.

Full scale ranges: 10, 20, 50, 100, and 200 peak volts.

Source: Robert M. Matheson and Leon S. Nergaard, RCA Labs, Princeton, N. J.; *RCA Review*, Dec., 1954.

TRANSISTOR ONE-SHOT MULTIVIBRATOR

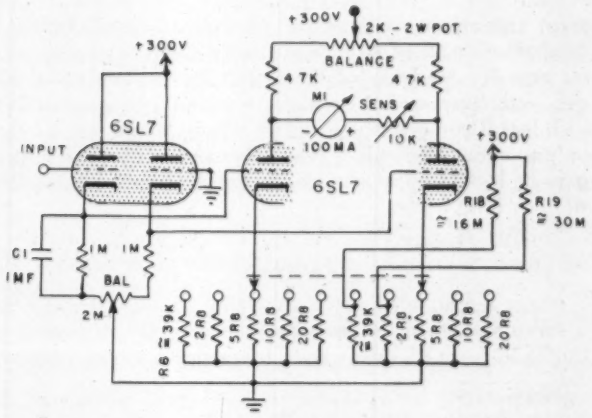
Analogous to the familiar vacuum-tube cathode-coupled one-shot (monostable) multivibrator, this circuit uses readily-available junction-transistor types (TI-201 or CK722). Delays as short as 5 usec and as long as several seconds may be obtained by proper choice of capacitor coupling the transistors (from 50 uuf to 10 uf). Negative-going trigger is applied to the common emitter via a diode.

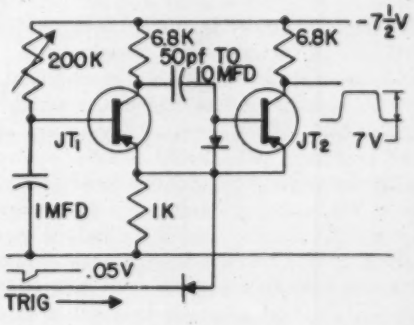
Trigger: 0.05-v amplitude and 1-usec duration required.

Output signal: Rise time is 2 usec with CK722; 1 usec with TI-201.

Supply: Minus 7.5 volts; current drain depends on duty cycle (pulse length and rep. rate).

Source: Frank C. Alexander, Jr., Gulf Research and Development Co., Pittsburgh, 30, Pa.; also *Electronics*, Dec., 1954.





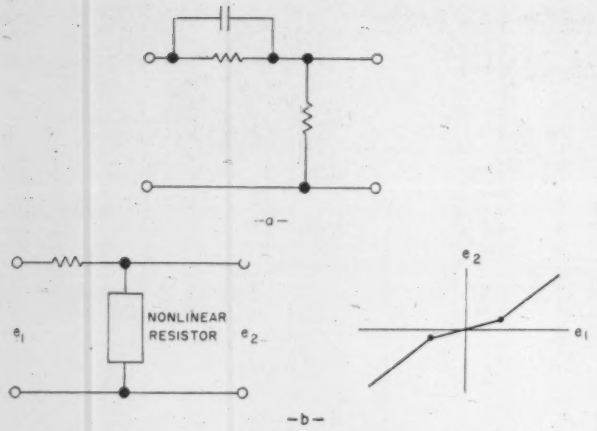
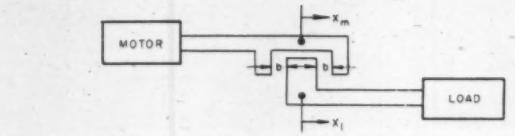


Fig. 1. Networks that can be used to compensate for backlash include (a) conventional linear phase-lead network which compensates for the phase lag introduced by backlash, and (b) nonlinear-resistor network which reduces the sensitivity near the null point, the point at which the effect of backlash occurs.



X_m = MOTOR POSITION

X_l = LOAD POSITION

X_c = CENTER OF MASS POSITION

M_m = MASS OF MOTOR & MOTOR CONNECTING ELEMENTS

M_l = MASS OF LOAD & LOAD CONNECTING ELEMENTS

M_c = MASS OF TOTAL SYSTEM

$$(2\text{-}1)\quad X_c = \frac{M_m X_m + M_l X_l}{M_m + M_l}$$

$$(2\text{-}2)\quad M_c = M_m + M_l$$

$$(2\text{-}3)\quad X_c = \frac{M_m}{M_c} X_m + \frac{M_l}{M_c} X_l$$

AND

$$(2\text{-}4)\quad \frac{dX_c}{dt} = \dot{X}_c = \frac{M_m}{M_c} \dot{X}_m + \frac{M_l}{M_c} \dot{X}_l$$

Fig 2. Simple motor-load translational system with backlash (b) in the coupling. Equations for the position and velocity of the effective "center-of-mass" are derived. X_m and X_l represent the linear translational position of motor and load, respectively.

Backlash Compensation Improves

Backlash in a servo-system can cause trouble near the system null. Here is a résumé of techniques for compensating for backlash, including (1) conventional phase-lead network, (2) nonlinear null-point network, (3) conventional rate signal (velocity feedback) for effective viscous damping, (4) center-of-mass velocity feedback, (5) split output-pinion with spring loading, (6) split gear-train with spring loading, and (7) split gear-train with biased motors.

ART of designing linear servo systems has been well perfected in the past two decades. With the advent of the analog computer, the analysis and synthesis of servomechanisms on a linear basis have been greatly simplified. Unfortunately, however, the control systems designer discovers that even with the above aids, his system when first tested does not always have the performance or stability anticipated. In addition, he often finds that he cannot design for the desired performance with any of the standard linear techniques.

Several factors contribute to his design difficulties. Backlash is one of the more important factors which limits the performance of servo systems designed upon a linear basis. Backlash exists in all physical mechanical systems. The degree to which it exists determines whether or not it will significantly affect servo performance. The effect of backlash is usually not noticed in system response except when the system is approaching steady state near the null. This is to be expected because the magnitude of backlash generally can be held, by standard means, to a value small compared to the normal transient disturbance.

Backlash can exist in any portion of a mechanical system. However, its most common location is in the high-powered mechanical linkages, gear trains, etc., connecting the servo motor to the output load. Although backlash can occur, for example, in the coupling elements between the load and the output sensor, it usually can be eliminated at this power level without appreciably increasing the total friction level of the system.

Backlash usually produces an oscillatory or wandering motion about the null. This condition can occur either when the system has come to rest or has reached steady state. Generally, such oscillations arise when the viscous output damping is relatively low, and will increase if too great an amount of error rate damping is used. Integral compensation, used to reduce steady-state error, also will increase the tendency of the system to oscillate about its null in the presence of backlash. For certain combinations of integral compensation and backlash, wandering of the output about the null is also observed. This wandering may be looked upon as a low-frequency nonlinear oscillation, or limit cycle.

Analysis

Many methods exist for analyzing the performance of a servo system in the presence of backlash*. However, a modified form of steady-state frequency analysis employ-

*McDonald, D. C., *An Appraisal of Nonlinearities in Servomechanisms*, National Electronics Conference, 1954, p. 2-9.

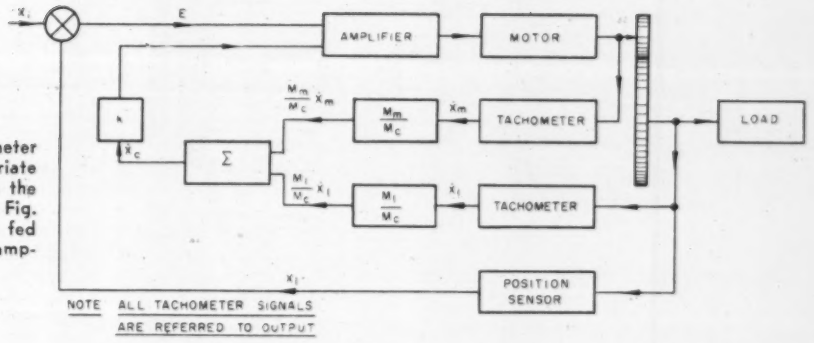


Fig. 3. Rate signals from the motor-tachometer and load-tachometer are added with appropriate scale factors to give a signal proportional to the velocity of the center of mass (as derived in Fig. 2). Composite center-of-mass rate signal is fed back to motor to introduce effective viscous damping.

SERVO-SYSTEM OPERATION

DONALD C. McDONALD, *Cook Research Laboratories*

ing the describing function appears to yield the most information concerning the effect of backlash and the methods of compensating for it. In this technique the *describing function* (or fundamental-frequency transfer function) is calculated for the elements containing backlash. This describing function is combined linearly with the transfer functions of the remaining linear elements in the servo system. The composite transfer function (containing the describing function) then can be plotted on a Nyquist or Bode diagram, and conventional analytical techniques used to analyze and synthesize the system.

Backlash introduces a negative phase shift (the describing function for elements with backlash yields negative phase lag) which is independent of frequency but which is a function of the ratio of the output motion to the backlash. This is why the effect of backlash upon system stability is usually only apparent around the null where the magnitude of output motion approaches the backlash motion. It is at this ratio of output motion to backlash that the phase shift from the backlash describing function becomes important.

The detrimental effect of backlash may be minimized by the utilization of lead networks, velocity feedback, and mechanical means.

1. Networks

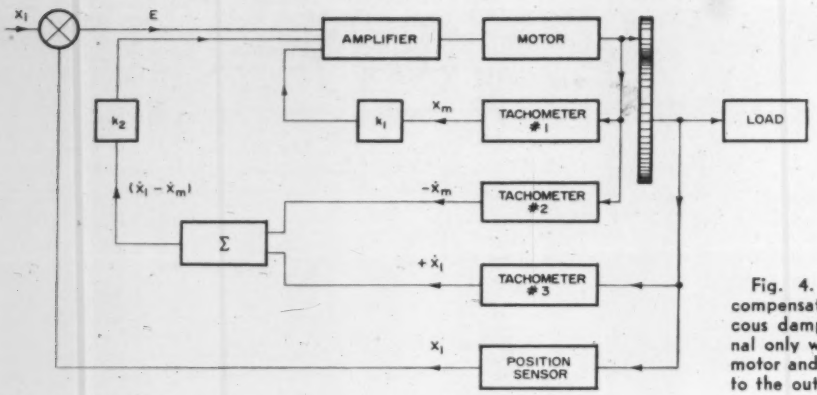
Conventional linear lead-networks (Fig. 1a) can be used to compensate for the negative phase shift introduced by the backlash. The network introduces a phase lead that compensates for the lag introduced by the backlash.

Nonlinear compensating networks (such as in Fig. 1b) also can be used to offset the effect of backlash. These latter networks reduce the sensitivity (gain) of the system in the vicinity of the null. Such networks have an output which is a nonlinear function of the input and, on an amplitude basis, are the complement of an integral or low-pass filter because they reduce the gain of the system as the phase shift approaches critical values.

2. Velocity Feedback

As mentioned, backlash produces stable oscillations around the null whenever the viscous output damping is relatively low. Viscous output damping can be increased by use of a tachometric output-velocity feedback, which produces the equivalent of viscous output damping. In this type of velocity feedback, the tachometer is usually coupled to the motor directly or through a short, backlash-free, instrument gear train. (Such a gear train can be made backlash-free because high-pitch precision gears can be used and any remaining backlash can be removed without introducing too much friction in the over-all system.) Such velocity feedback permits higher system gain without instability in the presence of backlash.

In the backlash region, the tachometer coupled to the motor supplies viscous damping to stabilize the moment of inertia of only the motor. The mechanical time-constant of the load is usually large and will produce a de-



LET

(4-1) $\dot{X}_{fb} = k_2(\dot{X}_i - \dot{X}_m) + k_1 \dot{X}_m$

IF

(4-2a) $k_1 = k$

(4-2b) $k_2 = k\frac{M_l}{M_c}$

THEN

(4-3) $\dot{X}_{fb} = k\left[\frac{M_l}{M_c}(\dot{X}_i - \dot{X}_m) + \dot{X}_m\right]$

COMBINING THE $\dot{X}_m$ YIELDS

(4-4) $\dot{X}_{fb} = k\left[\frac{M_m}{M_c}\dot{X}_m + \frac{M_l}{M_c}\dot{X}_i\right] = \dot{X}_c$

NOTE: ALL TACHOMETER SIGNALS ARE REFERRED TO OUTPUT

Fig. 4. Three-tachometer system for backlash compensation. Tach 1 supplies conventional viscous damping; tachs 2 and 3 supply damping signal only when relative motion takes place between motor and load. All tachometer signals are referred to the output.

stabilizing effect in the backlash region unless the moment of inertia of the load is small compared to that of the motor. As the moment of inertia of the load increases, some viscous damping must be added to the output in order to reduce the mechanical time-constant of the load.

It has been observed that as the ratio of the reflected moment of inertia of the load to the moment of inertia of the motor increases, the effect of motor tachometer feedback becomes less effective in offsetting the backlash. Under such conditions another form of tachometric feedback must be employed which will effectively offset backlash. This form of velocity feedback is referred to as *center-of-mass velocity feedback.*

Center of Mass

It is possible to choose a point in the motor, connecting elements, and output load combination which is called the center of mass. The center of mass has the property that it responds linearly to all forces applied to it. If a transfer function were derived for the center of mass of the system, instead of for the output alone, the describing function for the backlash element would be omitted and the over-all transfer function would be completely linear.

Fig. 2 shows backlash in simple translational elements. The equations for the position and velocity of the center of mass are derived in this figure.

In Fig. 2, X_m can have any value between $X_l + b$ and $X_l - b$. If these limiting conditions are substituted into equation (2-3), the position of the center of mass, X_c, will vary between $X_l + (M_m/M_c)(b)$ and $X_l - (M_m/M_c)(b)$. In addition, there are two limiting cases for the ratio: (1) when the motor moment of inertia is large compared to the load moment of inertia and (2) when the motor moment of inertia is small compared to the load moment of inertia. For the first case, X_c varies between $X_l + b$ and $X_l - b$; for the second case, X_c becomes equal to X_l.

As can be seen from Equation (2-4) of Fig. 2, the velocity of the center of mass is made up of the sum of two velocities which are proportional to the motor and load velocity.

Fig. 3 shows a system where a tachometer is coupled to the load as well as to the motor. In this system the two velocities are added together (with appropriate scale factors) to yield a signal which is proportional to the velocity of the center of mass. This composite velocity signal is fed back as is normally done with motor tachometer signals, and stability is greatly improved. Theoretically the effect of backlash would be totally negated if the positional feedback were taken from the position of the center of mass rather than from the output. Of course, such an approach is impractical because the center of mass can be out of position with respect to the output by the full backlash, and this could contribute to an undesirable error.

Some experimenters have designed by heuristic means a system to offset backlash which uses three tachometers as shown in Fig. 4. In this system tachometer number one supplies the normal viscous damping for the system without backlash, while tachometers numbers two and three supply a damping signal when relative motion takes place between the motor and load. As is demonstrated analytically in Fig. 4, this system is equivalent to the system of Fig. 3. Either system can be derived from the basic equations of Fig. 2 by simple rearrangement of terms.

In Figs. 3 and 4, all tachometer signals are referred to the output. In actual practice the tachometer coupled to the motor runs at a higher rate than the tachometer coupled to the load and will, therefore, generate an output which is larger than that generated by the load tachometer. However, by adjustment of sensitivities or by the use of attenuators, both tachometer signals can be made to produce the same number of volts per rpm of the output shaft.

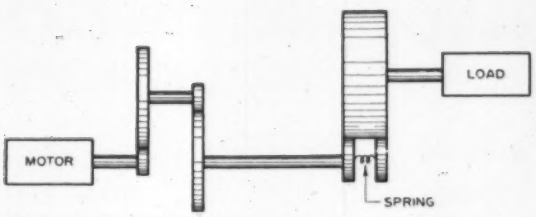


Fig. 5. Split output-pinion is the simple mechanical means for eliminating backlash in output mesh (where the backlash is the most important, in the majority of cases). When backlash is distributed throughout gear train, a complete split gear-train, as in Fig. 6, should be used.

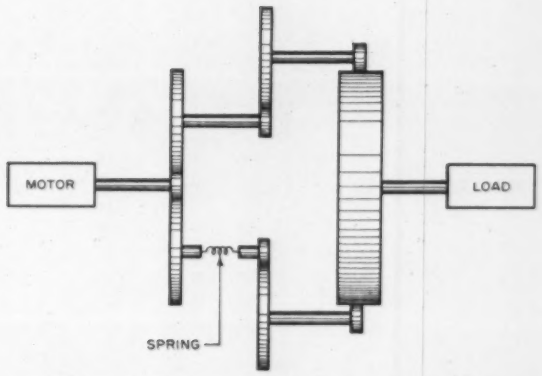


Fig. 6. Complete split gear-train takes up backlash distributed throughout gear train.

3. Mechanical

There are two approaches to offsetting the effect of backlash by mechanical means. One is to reduce the magnitude of the backlash in the connecting elements; the other is to substitute electromechanical networks for any of the previously described systems. As substituting electromechanical networks for electrical or tachometer networks is usually less flexible and more expensive than the original networks, no further consideration will be given to this procedure.

The usual first step in mechanically eliminating the backlash in the connecting elements is to reduce the allowable tolerances on gears, gear center distance, pivot clearances, etc. This reduction in allowable tolerances is limited by the accompanying increase in friction and reduction in life. After a balance has been made between backlash, friction, and life, the next step is to remove the remaining backlash by the introduction of spring-loaded gear trains. Such gear trains can take the simple form of a split output-pinion as shown in Fig. 5, or a complete split gear-train as depicted in Fig. 6. Backlash is removed from only the output mesh when a gear train like that of Fig. 5 is employed; however, the majority of the backlash normally occurs at the output mesh. When the backlash is distributed throughout the gear train the system of Fig. 6 is more useful.

In the systems of Figs. 5 and 6, spur gears are employed and the spring loading is achieved with simple spring members. Fig. 7 shows an alternate system wherein helical gears are employed and the spring is no longer a direct connecting element. Although the spring is not a direct connecting element, it acts the same as the spring in Fig. 5. (In the system of Fig. 7 the compression spring tends to take up the backlash through the wedge action of the helical gears.)

Fig. 8 shows another split gear-train where backlash is eliminated without use of a mechanical spring. In this system two motors and two parallel gear trains are employed. Although both motors are energized equally by the amplified control signal, there is a bias signal of opposite polarity injected into each motor, which produces opposing bias torques to take up the backlash around the null.

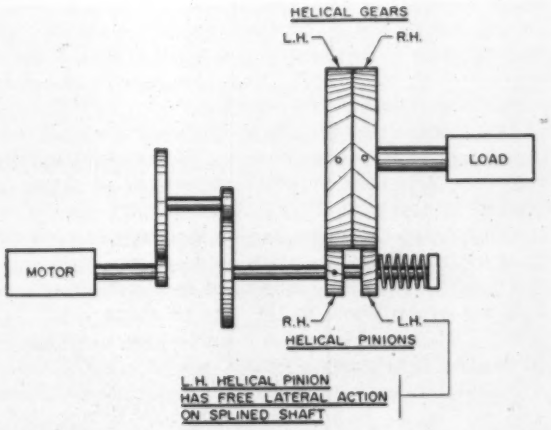


Fig. 7. Use of helical gears, rather than spur gears, permits spring to be used only to take up backlash, rather than as a direct connecting element. Left-hand helical pinion has free lateral action on splined shaft; hence compression-spring causes wedge action of helical pinion, taking up the backlash.

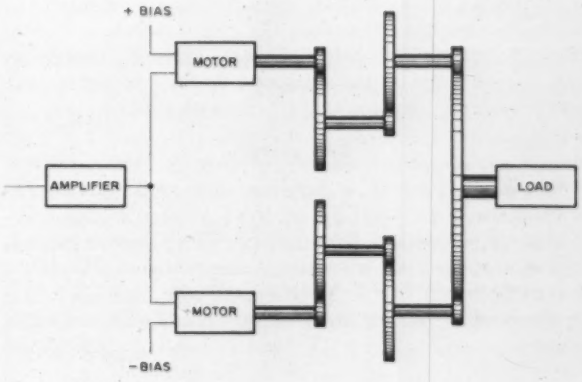
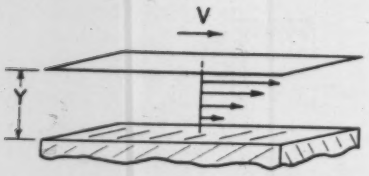


Fig. 8. Split gear-train wherein backlash is removed without use of a spring. Bias signal of opposite polarity is applied to each motor, thereby taking up the backlash around the null point.



$$F = \eta A \frac{dV}{dY}$$

F = Force in Dynes
η = Absolute Viscosity, Poise
A = Surface Area, Sq Cm
V = Velocity, Cm/Sec
Y = Plate Separation, Cm
$\frac{dV}{dY}$ = Rate of Shear, Sec^{-1}

Fig. 1. Absolute viscosity (η) is defined as shear stress per unit area (F/A) divided by rate of shear (dV/dY). It is constant for Newtonian liquids.

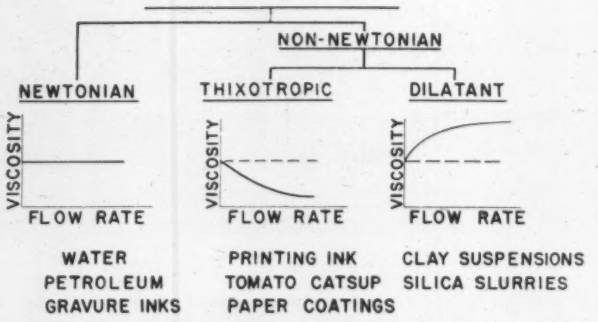


Fig. 2. Viscosity vs flow rate for various liquids. In Newtonians fluids, viscosity remains constant as flow rate increases; in thixotropic fluids, the viscosity decreases; in dilatant fluids the viscosity increases. (Temperature is assumed constant.)

Steel-industry Uses of

Fuel oil of uniform blend is required in open-hearth operations if undesirable sulfur is to be eliminated from the end product. Viscosity control of the oil provides a method for obtaining fuel of the quality desired for the burners. Included is a discussion of viscosity, Newtonian and non-Newtonian fluids, and an ultrasonic technique for viscosity control.

CONTROL of the viscosity of the fuel oil used in open-hearth operations is a new technique for improving the end product. This article reports on the use of an ultrasonic technique for viscosity control, particularly with the "Ultra-Viscoson," an instrument that uses an ultrasonically-energized probe to develop an electrical signal proportional to the viscosity of the medium in which the probe is immersed. The electrical signal is first fed to a "computer" before being indicated directly in units of viscosity by the computer indicator (or by any high-impedance electronic potentiometer circuit).

Viscosity

As viscosity is not as familiar a process variable as flow, pressure, temperature, or level, a definition and discussion of viscosity will be helpful. The simplest general definition states that "viscosity is a measure of the ability of a material to flow." More specifically, viscosity is a "measure of resistance to flow," and may be expressed as follows:

$$\text{Viscosity} = \frac{\text{Shear Stress}}{\text{Rate of Shear}}$$

This formula is illustrated in Fig. 1. If a movable plate with an area of one square centimeter is placed one centimeter away from a fixed plate of the same area, and if a fluid is contained between these plates, the force required to move the plate is proportional to the *rate of shear* to which the fluid is subjected. If F is the force in dynes, A the surface in square centimeters, V the velocity of the moving plate in centimeters per second, and Y the plate separation in centimeters, then η represents the *absolute viscosity in poises* in the equation shown in Fig. 1.

Fig. 1 shows that the action of shearing a fluid involves the motion of intermediate layers of that fluid at different velocities. The velocity gradient, or rate of shear, is expressed by the term dV/dY. The viscosity symbol η is a constant for so-called *Newtonian materials* (such as water, most hydrocarbons, mercury, and certain other commercial fluids). A material is defined as *non-Newtonian* when F is not proportional to the rate of shear, and viscosity is not a constant. Stated more simply, the material is non-Newtonian if viscosity changes as a function of flow rate.

Newtonian and non-Newtonian materials are characterized in Fig. 2. Two of the more simple types of non-Newtonian products are identified as *thixotropic* and *dilatant*. The curves of viscosity vs. flow rate indicate that (at a fixed temperature) the viscosity of thixotropic fluids decreases with increasing flow rate, and that the viscosity of a dilatant material increases with velocity of

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, 1955.

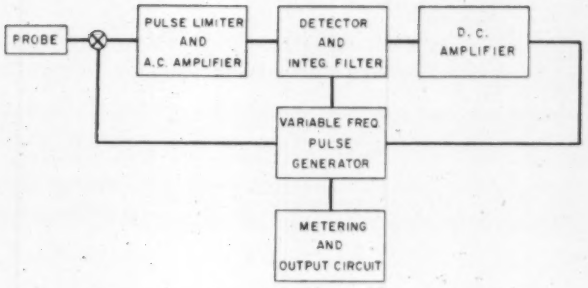


Fig. 3. Block diagram of Ultra-Viscoson system shows pulse generator which pulses probe whenever signal from probe decays to given level. Signal from probe is limited, amplified, detected, demodulated, integrated, and amplified again to form signal which triggers the pulse generator.

Fig. 5. The Ultra-Viscoson continuous-reading viscometer comprises an ultrasonically energized probe and "computer" with indicator calibrated directly in units of viscosity x density (centipoises x grams/cc).

VISCOSITY CONTROL

R. L. HILL, Cincinnati Division, Bendix Aviation Corp.

flow. These characteristics explain some flow control problems in the handling of residual fuels.

The Ultra-Viscoson

Fig. 3 shows the basic Ultra-Viscoson system, comprising a probe (which, like thermocouple assemblies, may vary in physical configuration) and an electronic computer and connecting coaxial cable. The standard computer (Fig. 5) contains a range-selector switch which permits a full-scale reading of 50, 500, 5,000 or 50,000 centipoises x grams/cc. Another type provides a useful range up to 500,000 centipoises x grams/cc. Electrical zero and calibration controls are provided for calibrating the probe-computer combination to standard fluids of known temperature-viscosity characteristics. In addition, a variable output control is provided so that a full-scale output up to 0-50 millivolts may be obtained for use with a standard electronic potentiometer-recorder or controller. The full-scale accuracy of this system is plus or minus 2%; the reproducibility is better than 1%.

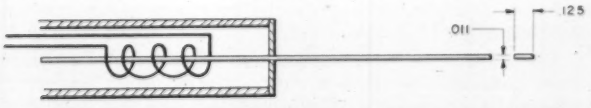


Fig. 4. Sensing element has reed in which ultrasonic longitudinal vibrations are induced by coil at the reed's resonant frequency of 28 kc. Reed is pulsed each time its amplitude decays to 1/500 of initial pulse. Time for decay, and rate of pulsing, is thus a function of viscosity.

Probe Assembly

Fig. 4 shows the principle of the probe assembly, which is the transducer. It acts alternately as a receiver and transmitter for ultrasonic energy. The sensing element proper is a 4" strip of magnetostrictive alloy, 0.011" thick for computer ranges to 50,000 centipoises, and 0.050" thick for ranges to 500,000 centipoises. The associated computer induces short pulses of current in the coil located within the probe barrel, causing the blade to vibrate at its natural frequency of 28 kc. The portion of the wave which emerges from the barrel is ¼-wavelength long at 28 kc. There is virtually no motion at the geometric center of the blade (where it is joined to the diaphragm), and the maximum excursion at the tip (2 inches from the diaphragm) is approximately ½ micron. The resultant alternating shearing action is in the longitudinal plane rather than at right angles to the blade length.

If an oscilloscope were connected to the terminals of the probe coil, a damped waveform would be observed each time a pulse was induced in the coil. This waveform would have diminishing peak amplitudes corresponding

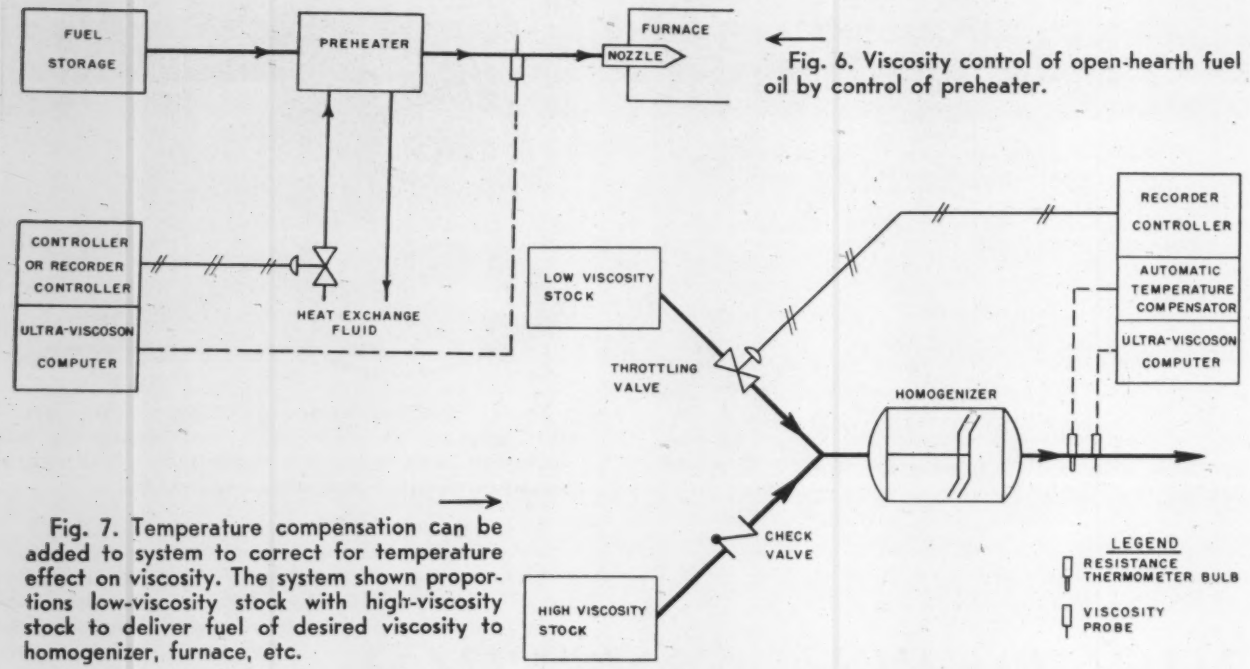


Fig. 6. Viscosity control of open-hearth fuel oil by control of preheater.

Fig. 7. Temperature compensation can be added to system to correct for temperature effect on viscosity. The system shown proportions low-viscosity stock with high-viscosity stock to deliver fuel of desired viscosity to homogenizer, furnace, etc.

to the diminishing amplitudes of the mechanical vibration of the probe blade. When the amplitude decays to about 1/500 of the original value, the computer transmits another pulse to initiate another wave train. The repetition rate of these wave trains is about 50/second when the blade is in air, and approximately 5000/second when the blade is in a fluid whose viscosity is the maximum of the computer range. As viscosity increases, the damped waveform increases in repetition frequency. The rate of response to viscosity changes is in the order of milliseconds, thereby providing an essentially instantaneous signal (compared to other types of viscosity-sensing elements).

A block diagram of the basic Ultra-Viscoson system is given in Fig. 3. The variable-frequency generator pulses the probe circuit. The probe, the a-c amplifier, the detector, the d-c amplifier, and the indicator circuit comprise the receiving circuit. The signal is amplified and rectified in the a-c amplifier branch; the detector removes the 28-kc component of the waveform; and the d-c amplifier controls the pulse generator. The indicating circuit responds to the average current delivered to it by the rectified and filtered waveform.

Multiprobe systems are available in which up to six probes (which can be located as much as a mile away from the central station) are used with one computer and multipoint recorder. The multiprobe panel contains individual zero, calibration, and viscosity-range selection controls for each probe. This feature provides flexibility, permitting different probes in the system to be applied to process fluids of varied viscosity in scattered areas of the plant. A selector switch permits the unit to operate continuously on any one probe or to scan sequentially all points of the system.

As viscosity varies with temperature, *automatic temperature compensation* may be required. The Bendix automatic temperature compensator (Fig. 7), now in development, continuously corrects the viscosity data for changes in process temperature. In this contemplated system, the uncompensated viscosity signal from the Ultra-Viscoson computer output is fed to the compensator, as is the temperature information from a resistance-thermometer bulb. The compensator then corrects the computer signal as necessary to correct for deviation from the selected average process temperature.

Applications

Typical examples of applications for the Ultra-Viscoson in the metallurgical industries include an acid-open-hearth installation firing a premium-grade blend of Bunker C and light oil which is batch blended on the premises (Fig. 6). Use of the Ultra-Viscoson to control fuel-oil viscosity quickly revealed that, although the controlled BTU input (steam) to the preheater satisfied the demand conditions to the extent of providing plus or minus ¼ centipoise variation from set point, fuel temperature drifted as much as 30°F. This reaction was attributed to poor blending, and resulted in temperature-viscosity stratification in the blended-fuel storage tanks. This created a condition whereby fuel blend ratios approached the extremes of straight Bunker C or Marine grade oil. An undesirable condition resulted in which a relatively high-sulfur fuel was used during the "melt-down" cycle. Use of a temperature-compensated batch-type-blending control system to provide a fuel of uniform viscosity solved the problem. The application cited above utilizes a single preheater with a fuel recirculation system from the several furnaces connected to the input side of the preheater.

Batch blending of fuel oils to a specified viscosity which approaches a continuous process is performed with equipment shown in Fig. 7. Here, the blending-process control arrangement requires automatic temperature compensation.

Cascade-type control may be considered for multi-furnace installations using a main, and auxiliary preheaters where fuel viscosity characteristics are influenced by factors such as furnace reversal. A single Ultra-Viscoson controller can determine the temperature which is required to hold a desired viscosity. This value then can be used to set the temperature of each preheater by use of remote-index controllers.

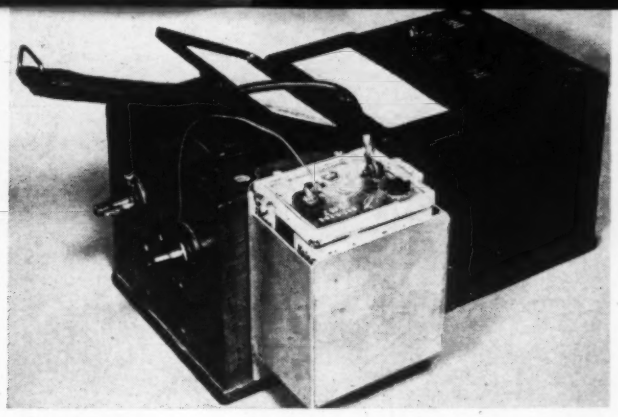


Fig. 1. Willard portable cell provides up to 100-amp source for field operation of Ducter Ohmmeter.

OHMMETER POWER SOURCES

F. J. TREBBY

Kaiser Aluminum & Chemical Corp.

IN THE Electrical Engineering Section of the Department of Metallurgical Research of Kaiser Aluminum & Chemical Corporation we need to measure the resistance of connectors, joints, terminals, welds, etc., both in the laboratory and in the field (sometimes at the top of a power-line pole). Low-resistance measurements can be made with an instrument known as the Ducter, distributed by the James G. Biddle Company, which also supplies the external power sources needed by the Ducter. Our needs, however, necessitated special power sources, which are described. (The Ducter is a cross-coil ratio instrument whose moving coils are mounted at a fixed angle with respect to each other and move in the field of a permanent magnet. As the reading depends on the *ratio* of voltage to current, small variations in supply power do not affect accuracy.)

Our Ducter (Cat. No. 713) requires a 100-ampere power source on the 0-100 microhm range; 10 amperes on the 0-1000 microhm range; 1 ampere on higher resistance ranges. We required a physically small power source for field operation, and a special laboratory source.

Portable Source

We have found an answer to the battery problem in the Willard portable cell (Fig. 1). The Willard Type 25-2 rechargeable battery is a compact unit only 2⅜" x 4¼" and housed in a light-weight polystyrene container of non-spill construction. It weighs only four pounds. It is used directly connected to the Ducter when 100 amperes are required for measurements in the 0-100 microhms range. However, on the next higher resistance range of the Ducter, the current must be limited to 10 amperes maximum to prevent damage to the instrument. It was found that a 2-inch length of #14 Nichrome wire inserted between the battery and the instrument was adequate for use on this and higher ranges.

Laboratory Source

For laboratory and fixed location use, the Ducter is provided with a rectifier-type power supply, constructed on a 10" x 17" x 3" chassis (Fig. 2). The supply provides 10 amperes continuously, or 100 amperes intermittently. Range changing is accomplished by transformer taps.

As indicated on the circuit diagram, Fig. 2, the transformer primary is connected to the 115-v 60-cycle supply through control circuits. Relay 1 is the N.O. main contactor which energizes the transformer primary when Push-button A is depressed. One pair of relay contacts serve as the line connection; the other pair holds the contactor closed by completing the coil circuit after Push-button A is released. Relay 2 is a N.C. contactor with contacts in series with the coil of Relay 1. Depressing Push-button B energizes Relay 2, opens its contacts, and Relay 1 is de-energized, opening the primary circuit.

Three selenium full-wave rectifiers connected in parallel are used across the transformer secondary winding to provide rectified output current. Owing to the intermittent rating of the supply on the 100-ampere d-c range, it is not necessary that the rectifiers be rated at a full 100 amperes (three rectifier stacks in parallel, each rated at 12 amperes d-c output continuous are capable of providing 100 amperes output for short periods if forced air ventilation of the rectifier cooling fins is employed).

To further protect the rectifiers on the high-current range, thermal overloads and a time limit disconnect relay were included in the control circuit. Each rectifier has a Klixon overload thermostat attached to an inside heat radiating fin. If the temperature of any rectifier should increase above 90°C, its thermostat contact opens. A time-delay relay in series with Push-button C automatically opens Relay 1 after 7.5 seconds of operation; this time is adequate for a reading.

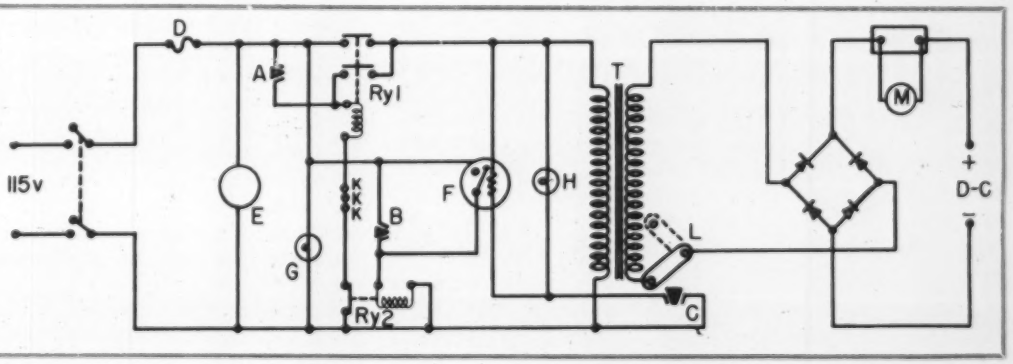


Fig. 2. Rectifier-type supply uses three 12-amp-rating selenium full-wave rectifiers in parallel to provide intermittent 100-amp source.

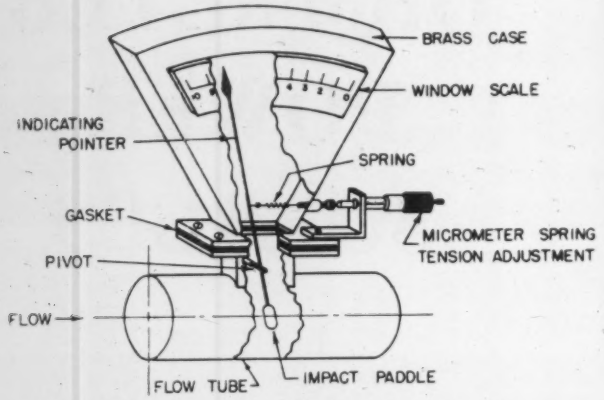


Fig. 1. First flowmeter investigated was the mechanical-impact type. Fluid impact on member projecting into stream develops force proportional to flow rate. Readings are made by viewing pointer through graduated window. Most serious disadvantage was that calibration was affected by hose inlet and outlet configuration.

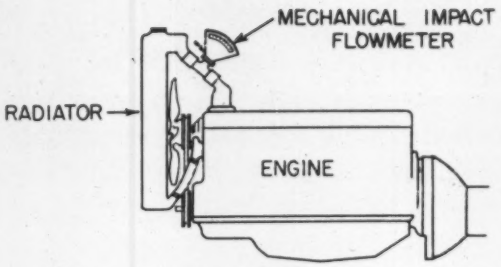


Fig. 2. Mechanical impact flowmeter installed on engine.

An Automotive-Cooling-System

REQUIRED: A flowmeter to measure flow rate of coolant in an automotive-type engine; flowmeter to be unaffected by inlet and discharge hose configurations.

SOLUTION: A 4-stage hydraulic-impact flowmeter with no moving parts, and with an accuracy of about 2%. Also discussed are the various types of flowmeters tried.

INSTRUMENTATION is available for analyzing the performance of various components of an automotive-type engine. However, little has been done toward providing equipment to measure flow rate of engine coolant when the engine is in an automobile and operated under various service conditions. As a result, work has been accomplished to develop a flowmeter which would be simple, inexpensive and accurate.

Equipment

To evaluate various flowmeter types, each meter was installed between a controlled water source and a collecting drum mounted on a weighing scale. Water was run through the meter at a controlled rate and discharged into the collecting tank over a period of time, where it was weighed, to determine the meter's calibration characteristics.

To observe the effect of various entry and discharge configurations upon each meter's calibration, a number of automotive-cooling-system hoses of different shapes were installed immediately before and after the meter in several combinations. An automotive-type thermostat also was installed upstream from the meter in some tests and positioned to reproduce as nearly as possible the pertinent cooling system sections found in currently manufactured American passenger cars.

The Mechanical Impact Flowmeter

Three different flowmeter types were investigated—(1) a mechanical impact flowmeter, (2) a single-stage hydraulic impact flowmeter, and (3) a four-stage hydraulic impact flowmeter. The first, of the mechanical impact type shown in Fig. 1, was installed in the cooling system of the car as in Fig. 2. This instrument operated on the principle that for a fluid flowing through a given diameter tube, the impact of the fluid upon a member projecting into the stream would be proportional to the velocity head of the fluid and, hence, proportional to the rate of fluid flow through the tube. Readings were made by viewing the pointer through a graduated window mounted on the body of the instrument. To provide varying degrees of flowmeter sensitivity and range, a spring tension adjusting screw, whose position could be accurately determined by means of a body-mounted micrometer, was included.

The mechanical impact flowmeter was simple in construction and operation, and adaptable to any currently manufactured automotive cooling system. However, serious disadvantages were found, including (1) the calibration was affected by the entry and discharge configura-

*Collaborators: R. S. WETMILLER and E. F. KOENIG, Beacon Laboratories, The Texas Co., Beacon, N. Y.

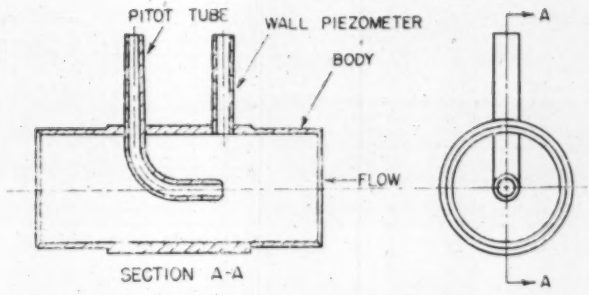


Fig. 3. Single-stage hydraulic impact flowmeter, comprising pitot tube for measuring velocity head and a wall piezometer for measuring static head, also suffered from calibration dependance on hose configuration.

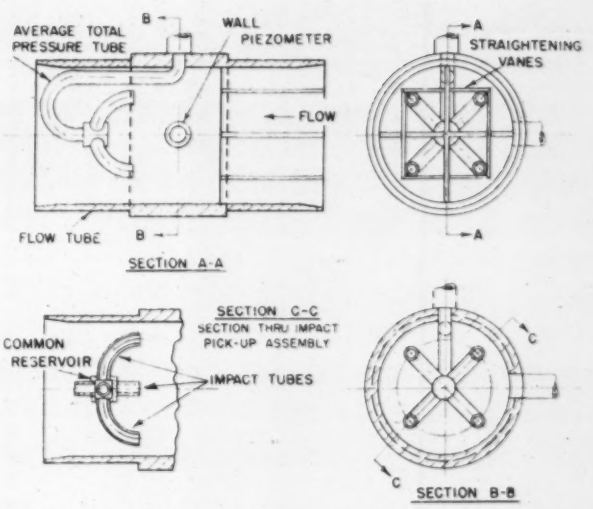


Fig. 4. Four-stage hydraulic impact flowmeter gives flow readings that are relatively independent of velocity gradient across test section.

FLOWMETER

EVERETT M. JOHNSON*

Beacon Laboratories,
The Texas Company

tions of the coolant lines, (2) the engine coolant had a tendency to cloud due to rust or other contaminants, making it difficult to observe the indicator pointer through the transparent window, (3) the pointer pivot was immersed in the coolant and its setting was affected by temperature changes of the coolant, and (4) the pointer spring was immersed in the engine coolant, which subjected it to temperature changes and corrosion, and affected the spring's calibration.

The Single-stage Hydraulic Impact Flowmeter

Owing to the disadvantages of the mechanical impact flowmeter, a single-stage hydraulic impact flowmeter was investigated. As shown in Fig. 3, this consisted of a pitot tube to measure the velocity head of the fluid, and a wall piezometer to measure static head.

This meter had the following advantages: (1) Simplicity—No moving parts to get out of alignment or calibration. (2) Distant Reading—Differential manometer attached to the pitot tube and wall piezometer could be mounted away from the car, eliminating the necessity of raising the hood to obtain a reading. (3) Improved Readability—Readings were much steadier under all flow rate conditions than those of the mechanical impact flowmeter.

Despite the advantages, this meter also was unsatisfactory because its calibration also was unacceptably influenced by the entry and discharge hose configurations found in automotive engine installations.

The unsatisfactory operation of the single-stage hydraulic impact flowmeter was caused by two reasons: First, the impact tube records only that force which is perpendicular to the plane of opening of the tube. When a sharp curve or obstruction precedes the flowmeter, the true velocity of the flow might be other than perpendicular to the plane of the opening in the impact tube. To minimize this effect, it was decided to insert straightening vanes in the flowmeter immediately before the impact tube. Second, the approach (straight, curved or obstructed) greatly influences the velocity gradient across the test section, and a single pitot tube may provide different manometer readings for a given flow rate in different installations.

Multi-stage Hydraulic Impact Flowmeter

Realizing this, a multi-stage hydraulic-impact pickup was designed (Fig. 4) which indicates a resultant velocity head across the test section and which gives constant velocity head readings for a given flow rate regardless of the velocity gradient of the fluid across the test section. Fig. 5 shows an installation of this unit in an automotive cooling system.

This instrument employs a wall piezometer to record the static head of the fluid and a four-stage pickup which records a resultant head of the four impact-tube openings (accomplished by constructing all of the impact tubes the same size, length and shape, and by directing the tubes to a common reservoir). From the reservoir, a single tube

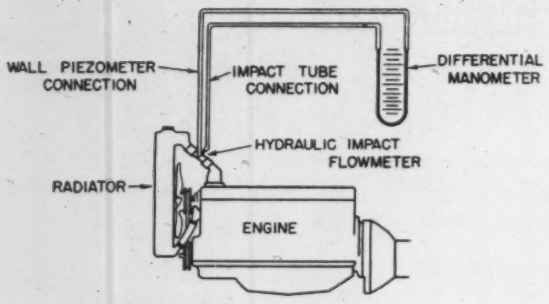


Fig. 5. Flowmeter installed on engine.

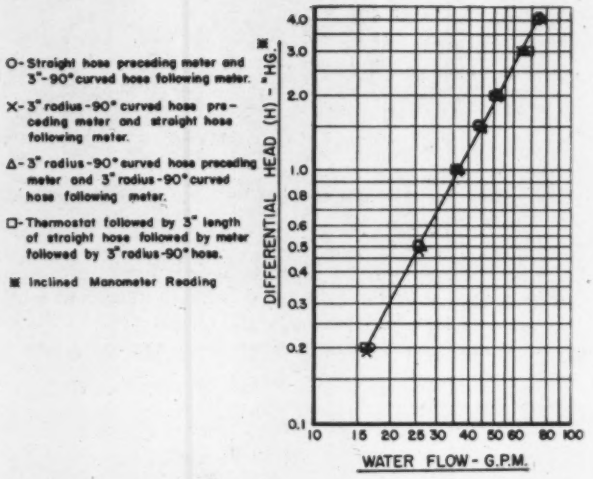

O- Straight hose preceding meter and 3"-90° curved hose following meter.
X- 3" radius-90° curved hose preceding meter and straight hose following meter.
Δ- 3" radius-90° curved hose preceding meter and 3" radius-90° curved hose following meter.
□- Thermostat followed by 3" length of straight hose followed by meter followed by 3" radius-90° hose.
▣ Inclined Manometer Reading
DIFFERENTIAL HEAD (H) - "HG.
4.0
3.0
2.0
1.0
0.8
0.6
0.5
0.4
0.3
0.2
0.1
10 15 20 25 30 40 50 60 80 100
WATER FLOW - G.P.M.

Fig. 6. Calibration of 4-stage impact flowmeter with 1.361-inch ID and straightening vanes, showing insensitivity to various hose configurations.

transmits the reservoir head to one side of a differential manometer, the other side of which is connected to the wall piezometer.

Although no traverses were made across the test section of the flowmeter to determine the velocity head at the opening of each impact tube under different conditions of flow, hypothetical velocity gradients across the test section were assumed and the resultant velocity head at the reservoir calculated. These calculations indicated that the reservoir would not necessarily have a resultant head equal to the arithmetic average of the individual impact-tube velocity heads under all conditions of varying velocity gradients across the test section. This is of no practical significance, however, because experimental tests indicated that regardless of the entry or discharge hose configurations, the four-stage hydraulic impact flowmeter retained a constant manometer reading for a given flow rate, as shown by the calibration data for a flowmeter of this type (Fig. 6). The data indicate an accuracy of about two percent or better.

Comparison of the flow rate measured by this instrument with its theoretical flow rate indicates that the flowmeter has a coefficient of approximately 0.95. This represents a substantial increase over the published average coefficient of 0.84 for a single-pitot-tube flowmeter.

Several models were built in varying sizes to accommodate the different cooling-system hose sizes encountered in current manufacture passenger cars. During calibration tests on these latter units it was found that:

Table 1.—Calibration Data for Various 4-Stage Hydraulic Impact Flowmeters.

Meter No.	Inside Diameter (inches)	Coefficient of Discharge, c	Constant K in $Q = K\sqrt{h}$
A-1	1.624	0.87	47.0
A-2	1.629	0.87	47.7
B-1	1.500	0.84	39.0
C-1	1.374	0.93	36.5
C-2	1.377	0.90	35.4
D-1	1.250	0.85	27.8
E-1	1.124	0.90	23.8
E-2	1.125	0.89	23.6
Experimental	1.361	0.95	36.5

1. Each flowmeter must be calibrated individually.
2. The position of the impact tubes is important in nullifying the effect of entry and discharge configurations on the meter's accuracy.
3. There apparently is no common point where the impact tubes should be located for all flowmeters; the exact position of the impact tubes may vary with each impact tube and each meter.
4. Slight changes in the position of the impact tubes allow the entry configuration to produce errors in the accuracy of the calibration of the meters.
5. When the impact tubes are properly positioned, the meter calibration curve is constant regardless of entry or discharge configurations.

Pertinent calibration data from the meters are shown in Table 1. These flowmeters were calibrated and have been used only with water. However, they may be used with liquids of other densities or at various temperatures either by calibrating them with the liquid to be used or by applying a fluid density correction factor of $\sqrt{d_1/d_2}$ to the water calibration-curve results (d_1 is the density of water at the calibration temperature and d_2 is the density of the test fluid).

Conclusions

The four-stage hydraulic impact flowmeter has the following desirable characteristics: (1) It is simple in design and has an accuracy of about two percent. (2) It contains no moving parts. (3) It may be made in any size for installation in any automotive cooling system. (4) Its accuracy and calibration are unaffected by either the entry or discharge line configurations immediately preceding and following it. (5) Flow-rate readings may be readily observed without disturbing the vehicle under test.

Acknowledgement

Acknowledgement is given to Mr. J. J. Kane for his participation in the development of the four-stage hydraulic impact flowmeter.

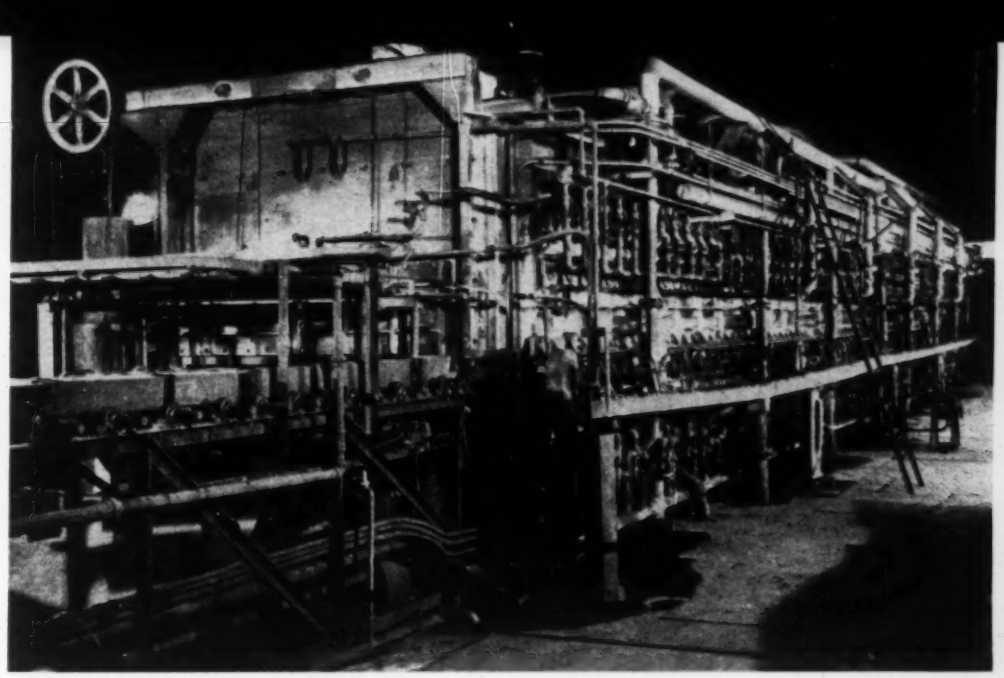


Fig. 1. High-temperature annealing furnace for 1600-2100°F range has continuous temperature control.

CONTINUOUS ANNEALING of SPECIALTY STEEL

T. J. O'KEEFE, Crucible Steel Company of America

Two specially built furnaces (for different temperature ranges) with controls for continuous annealing give Crucible's Park Works decided advantages in the finished products over the conventional batch process. They use thermocouples as sensing elements and galvanometer-type null-balancing controllers of the "on-off" form to electrically operate adjustable-port-type valves in the combustion-air lines. The annealed work turned out has uniform properties with a minimum of surface oxidation, optimum decarburization, and requires only slight straightening and flattening.

PARK WORKS of crucible Steel Company of America, Midland, Pa., is a specialty producer, turning out hundreds of compositions in various standard sizes and special shapes to particular metallurgical requirements, including microstructure, decarburization and mechanical properties. Two continuous furnaces are used for applying annealing treatments. Temperatures and times must be controlled accurately for the specialized metallurgical requirements, particularly where rapid and uniform cooling is required after heating for a controlled time interval to a closely controlled temperature. One furnace operates at temperatures up to 1600°F; the other from 1600 to 2100°F.

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, 1955.

High-temperature Furnace

The high-temperature furnace is a radiant-tube-heated, natural-gas-fired, roller-hearth furnace (Fig. 1) featuring silicon-carbide radiant tubes and rollers. The furnace is 5′6″ wide between the flanges at the ends of the rollers, and is 70′ long. Rates of passage through the furnace can be varied from approximately 40 ft/min to 5 ft/min.

Instrumention

The furnace temperatures are measured and controlled by seven galvanometer-type null-balancing temperature indicating controllers, one for each zone of control (Fig. 2).

The control thermocouples are 20-gage platinum vs platinum-13%-rhodium types, protected by a porcelain

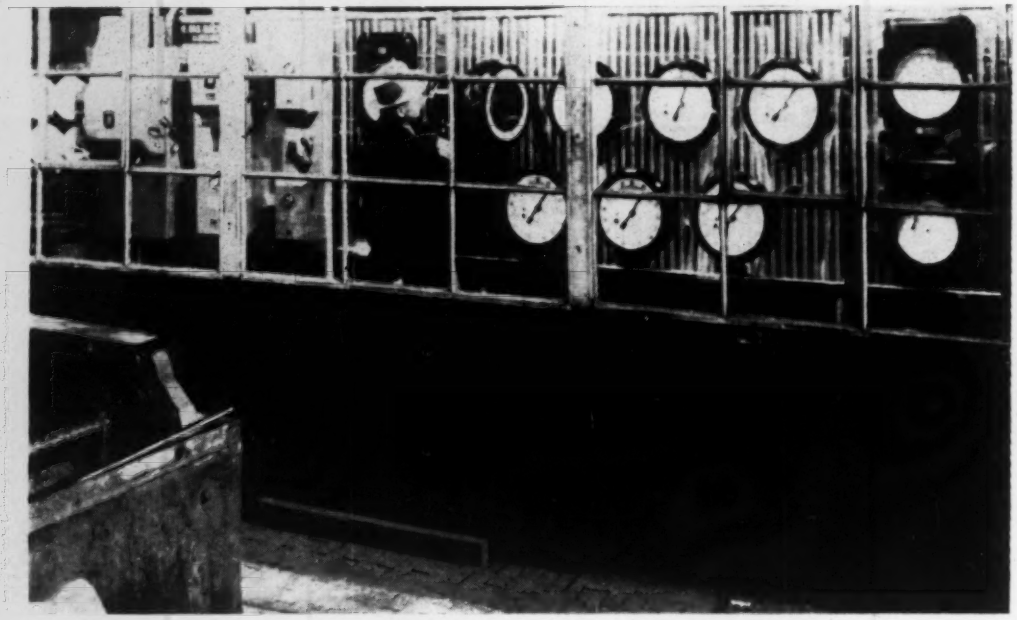


Fig. 2. Instrument room for high-temperature furnace has seven null-balancing temperature recorder-controllers, one for each zone of control. Sensing elements are pt vs pt-rhodium (13%) thermocouples. Controllers are on-off type, and actuate electrically-operated adjustable-port-type valves.

tube which in turn fits into a silicon-carbide outer tube. Each couple is situated in the center of each zone on the burner side, and just above the rolls. The end of the carbide protection tube is flush with the wall. It was found that a short conical-shaped depression in the wall around the end of the tube increased the accuracy of the control.

The on-off-type recorder-controller for each zone energizes electrically-operated adjustable-port-type valves in the combustion-air line.

Firebrick tile is used around the rollers, and insulating firebrick elsewhere. This results in maximum heating efficiency and minimum heat-up time.

The two distinctive features of this furnace are its hearth rollers and radiant heating tubes (Fig. 3). Silicon-carbide rollers avoid metal "pickup" which can occur with alloy metal rollers, can support greater loads at higher temperatures than alloy metal rollers, and can be stopped for long periods at high temperature without deforming.

Each roller consists of a silicon-carbide sleeve, 6″ O.D., enclosing a second refractory sleeve which is mounted on a hollow metal tube. Four of these refractory-covered tubes, 18″ long, are placed abreast on a single axle shaft. Filtered river water pumped at a rate of 141 gpm is used for cooling. Heated by 140 radiant tubes, also of silicon carbide, the furnace is divided into seven control zones. Each zone is 10′ long and contains ten tubes above the hearth and ten below. They make possible the attainment of uniform, high temperatures up to 2100°F and give faster heating rates than heat-resisting alloy metal tubes.

Tube failures are caused mainly by cracking under the impact of part of the load when a jam occurs in the furnace. The annual replacement, however, is not over 10%. Direct flame impingement through a broken tube, with its disastrous effects to the finish of the work, is prevented by creating a negative pressure inside the tube caused by a venturi tube section at the eductor elbow. The effect is obtained by introducing aspirating air of 24 oz per sq in pressure into the bottom of the eductor venturi section. This is done by a 700-cfm turbo blower.

Burners

The burners are manifolded together in groups of twenty, with an aspirator mixer for each burner. One-thousand-BTU natural gas at 16 oz per sq in pressure is supplied to a zero governor for each group of burners. It is aspirated into the burners by the flow of combustion air which is supplied by a 2700-cfm turbo blower located on top of the furnace. Gas consumption, maintaining a neutral atmosphere of 2-3% O_2 in exhaust gases, averages 16,000 cfh.

The furnace is used for annealing austenitic stainless, oxidation-resisting and acid-resisting sheet and plate in the "300" series of compositions. Sheet and plate in the non-hardenable Type 446 stainless are also annealed in this equipment. Table 1 shows typical compositions annealed, including temperatures, time for two thicknesses, and method of cooling. It is important that these annealing temperatures be uniform and accurately controlled because the times shown are the minimum that can be used.

This uniformity and accuracy of temperature control is also important for Type 446 sheet intended for forming operations. For such applications grain size must be kept uniformly fine during annealing, and this is to a large degree a function of time and temperature, since this grade is particularly susceptible to grain growth.

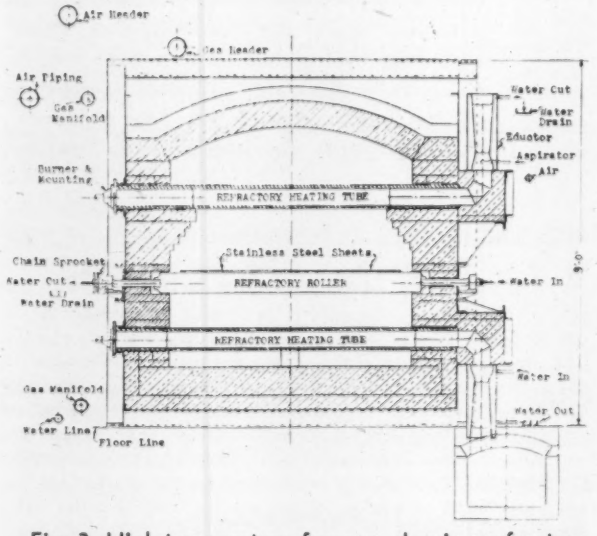


Fig. 3. High-temperature furnace, showing refractory roller and heating tubes.

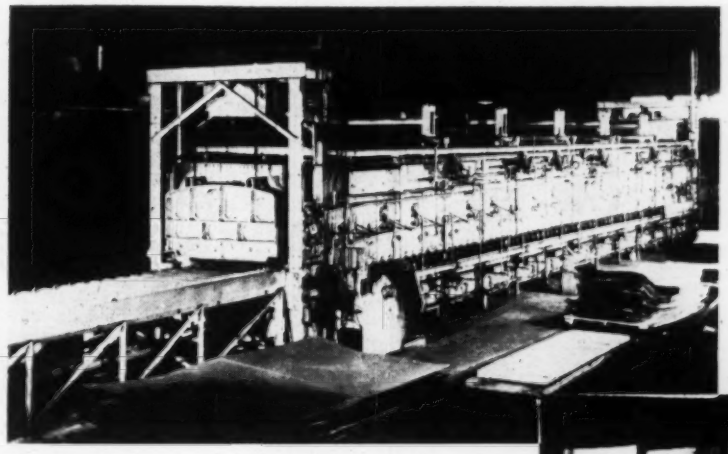


Fig. 4. Furnace for use up to 1600°F has six zones, each controlled by chromel-alumel thermocouples in center of roof and extending to about 24" above rolls.

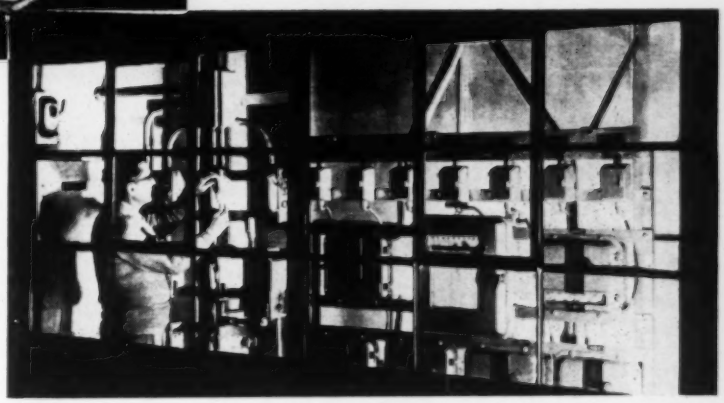


Fig. 5. Instrument room for low-temperature furnace has single recorder for recording temperatures in six zones of furnace, and six indicating controllers (shown below and beside recorder) which actuate electrically operated on-off gas valves.

Other high alloy non-stainless compositions suitable for treatment in the furnace are the high manganese, high nickel, non-magnetic type, and Hadfield manganese sheet, plate, and bar stock. It is also useful for the normalizing of AISI 4130 aircraft and constructional sheet and plate.

The quenching operation is performed with high-pressure steam to obtain the rapid cooling necessary for certain of the austenitic stainless grades such as Type 302, or Type 310, and the Hadfield alloy. This quench is considerably more efficient than high-pressure water for preventing the precipitation of the objectionable carbide phase in some of the "300" series compositions such as Type 310. Large fans are used to obtain the somewhat slower cooling rates necessary to meet the minimum tensile properties usually specified for normalized AISI 4130 sheet.

Table 1.—Typical annealing programs for stainless steels of 300 Series in high-temperature furnace.

							ANNEALING			
AISI TYPE	ANALYSIS						TEMPERATURE	TIME (MINUTES)		COOLING
	C	SI	NI	CR	MO	CB		18 GA	13 GA	
304	.08 MAX	1.00 MAX	8.00 11.00	18.00 20.00	—	—	1950°F ± 20°	2	4½	WATER AIR
316	.10 MAX	1.00 MAX	10.00 14.00	16.00 18.00	2.00 3.00	—	2000°F ± 20°	2	4½	WATER
347	.08 MAX	1.00 MAX	9.00 12.00	17.00 19.00	—	10XC MIN	2000°F ± 20°	2	4½	AIR

Table 2.—Typical annealing programs for steels annealed in low-temperature furnace.

GRADE	ANALYSIS						SIZE	TEMPERATURE		TOTAL TIME
	C	MN	NI	CR	MO	V		FIRST HALF	SECOND HALF	
AISI 6150	.48 .53	.70 .90	—	.80 1.10	—	.15 .25	1½" x 3/16"	1450°F	1300°F	50 MIN
CR. V.	1.00 1.10	—	—	.40 .60	—	.15 .25	2" x ½"	1430°F	1280°F	60 MIN
FILE STEEL	1.20 1.30	.20 .35	—	—	—	—	½" RD	1400°F	1330°F	60 MIN

Low-range Furnace

The furnace operating in the range up to 1600°F is shown in Fig. 4. It is a natural-gas-fired roller hearth, divided into six zones. The end zones are 12′ long, the four others are 9′ each, adding up to a total of 60 feet.

Each of the six zones is controlled by a chromel-alumel thermocouple located in the center of the roof and extending through the roof arch so that the ends of the protection tubes are about 24" above the rolls. For each zone there is an indicator-controller with a single continuous recorder, as shown in Fig. 5, actuating electrically-operated on-off gas valves. The air/gas ratio is adjusted to give a neutral atmosphere in the furnace.

The rolls are made of 25% Cr, 12% Ni alloy steel. They are capable of sustaining 50 lb per sq ft of hearth.

The furnace is heated by 80 high-pressure burners using 1000-BTU natural gas at 25 psig pressure with a total capacity of approximately 6000 cfh.

This furnace is used (1) for the cycle annealing of sheet and small bar stock, using TTT cycles, (2) the tempering of natural sheet or bar to close hardness ranges and (3) the stress relieving of cold-drawn bar stock or cold-rolled sheet. Typical grades, cycle annealed, are shown in Table 2.

Tempering or sub-critical annealing of natural condition stock to special properties (such as 3½% chromium magnet steels or bar stock for chisel applications) is easily possible with this equipment. Hardness control within 5 points Rockwell C poses no particular problem.

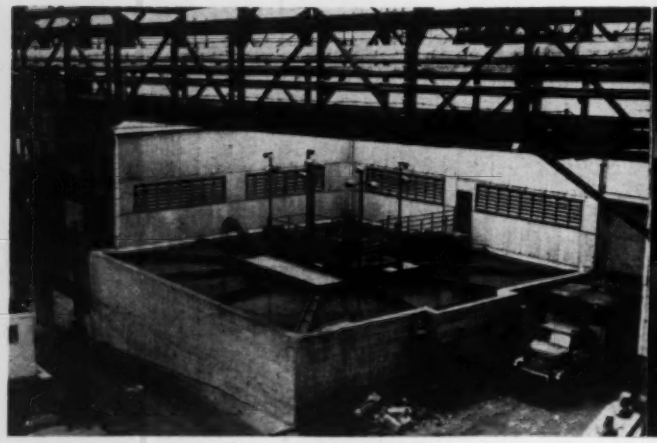


Fig. 1. Clarifier basin.

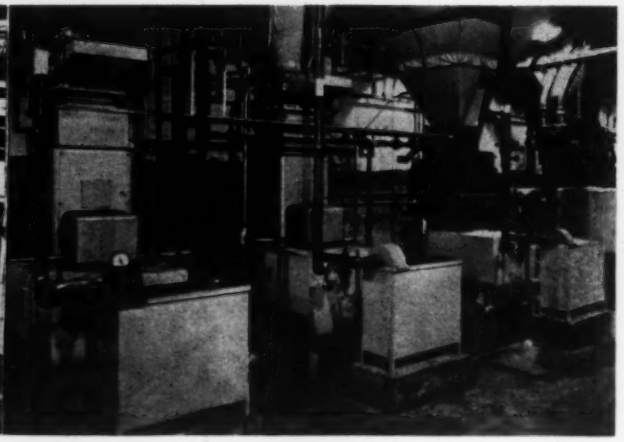


Fig. 2. Chemical-feed installation.

Instrumentation of a

WATER-TREATMENT PLANT

High-quality soft water is essential for steam-generating facilities. Here is a résumé of the instrumentation of a modern industrial water-treatment plant, including clarifier, filter beds, clearwell, sodium-zeolite softeners, and operating factors.

NEW WATER-TREATMENT plant was installed in 1951 at the Pittsburgh Works Division of the Jones & Laughlin Steel Corporation, South Side location. The function of this plant is to condition and treat Monongahela River water for use in the several steam-generation plants serving the Pittsburgh Works.

Prior to the installation of the water-treatment plant, soft filtered water was supplied from a cold-process lime-soda batch system, in use for many years. This system consisted of four tanks of 360,000-gallon capacity for sedimentation and softening, followed by conventional gravity-filter-bed equipment. Under the former batch process, the best average effluent water hardness attainable was about 1.5 grains per gallon (26 parts per million); the equipment currently in use produces a clear water averaging about 0.1 grain per gallon (2 ppm in total hardness).

Source Water

The Monongahela River is the source of raw water. The quality of this raw water depends on seasonal changes, rainfall, operation of flood-control-dam run-off, and treatment accorded the water by upstream users. Hence the clarity, hardness, and degree of acidity fluctuate over a wide range, as shown in Table 1.

Presented at Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 25, 1954.

Initial pH Adjustment

River water drawn in at the pump-house intakes receives a lime-slurry treatment for pH adjustment. The automatic lime-control equipment normally is set to maintain an average of about 6.4 pH. Control of acidity is practiced to prevent corrosive attack on the steel-plant cooling and heat-exchange equipment; it is not done to aid the water-treatment process for feedwater steam-plant use. Nevertheless, although added for another purpose, liming of river water does have a beneficial effect on that water processed by the treatment plant.

Table 1.—Analysis of Monongahela-River Water

	Concentrations		
	High	*Average*	*Low*
Calcium (Ca), ppm	76.0	30.0	21.0
Magnesium (Mg), ppm	19.0	8.0	5.0
Sulfate (SO_4), ppm	440.0	168.0	75.0
Total Hardness As $CaCO_3$, ppm	268.0	108.0	73.0
Total Dissolved Solids, ppm	659.0	267.0	129.0
Total Suspended Solids, ppm	27.0	150.0	635.0
pH Value (Est.)	4.0	5.0	5.8

Note: 17.1 ppm Equals 1 Grain Per Gallon

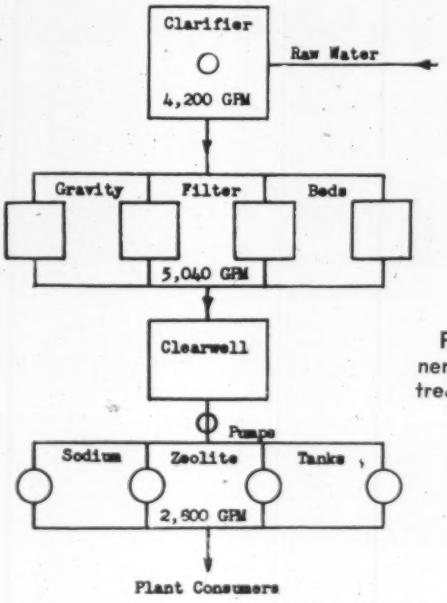


Fig. 3. Components of water-treatment plant.

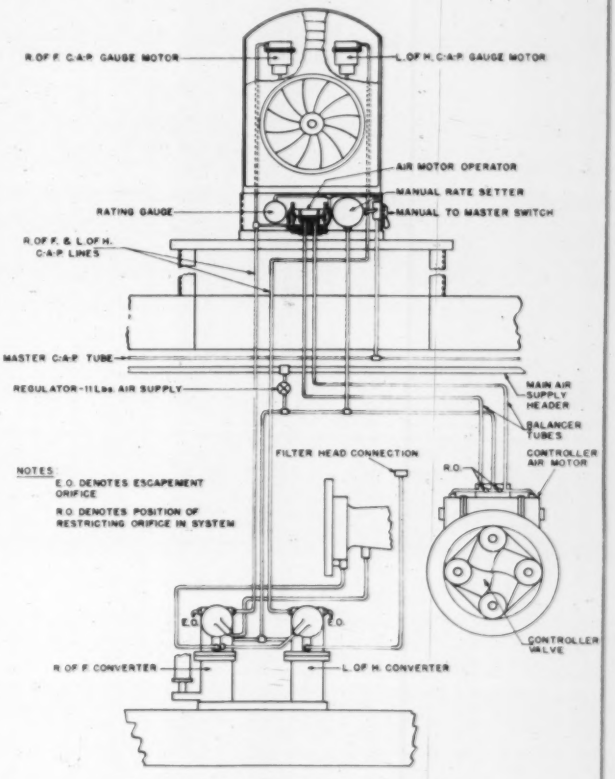


Fig. 4. Filter-bed control system.

G. E. REID
Jones & Laughlin Steel Corp.

Treatment Plant

Fig. 3 is a flow chart showing the main components of the treatment plant. Most controllers are operated by compressed air. This is a departure from the conventional practice of using filtered water, delivered at clearwall pump pressure, as the control medium. However, water-operated controllers are prone to freeze during cold weather, and to develop packing-gland leakage. Hence air control was specified. This decision was influenced by the fact that a dependable compressed-air supply was available.

Clarification Basin

The clarification basin (Fig. 1) collects the suspended solids in the water supplied to it, precipitates and rejects turbidity, and produces an effluent water having a suspended solids content of 10 ppm or less. To secure water clarity of this degree, proportioned additions of alum, lime, and soda ash are necessary. By further adjustment of the soda-ash feed, the clarifier functions as a hardness-removal unit.

During periods of cold (when water approaches its maximum density at about 39 deg F), and during runs of high river-water-turbidity, activated silica is fed to the clarifier. All chemicals are added to the clarifier on a metered control basis (Fig. 2). Raw water flow to the clarifier is measured by a recording and integrating flow-meter. An impulse switch attachment to the integrator, supplies an electrical signal to each of the chemical feeders at the passage of each 1700 gallons of water into the clarifier, rendering them operative for a set time limit. Hence the amounts of chemical pumped to the clarifier are proportional to the raw-water-loading imposed.

Sludge is removed from the basin by four automatic control valves whose actions are governed by electric timers. Sludge precipitated at four points in the basin is thus discharged to the sump.

A level control maintains a reasonably constant height of water in the clarifier. This device, actuated by a weight displacement element, delivers a controlled air pressure to the raw-water flow-control valve, causing it to maintain stable level in the clarifier.

Table 2 gives a comparative analysis of water both before and after treatment in the clarifier. Note that the suspended solids content undergoes a sizeable reduction, that the hardness is lessened, and that the pH value and the dissolved-solids content is raised.

Table 2.—Analysis of Water at Various Stages Of Treatment

	Clarifier Inlet	*Clarifier Effluent*	*Zeolite Effluent*
Calcium (Ca), ppm	71.0	39.0	1.0
Magnesium (Mg), ppm	19.0	12.0	—
Sulfate (SO_4), ppm	335.0	320.0	335.0
Total Hardness As $CaCO_3$, ppm	254.0	148.0	2.0
Total Dissolved Solids, ppm	585.0	615.0	620.0
Total Suspended Solids, ppm	68.0	7.0	1.0
pH Value	6.4	7.4	7.5

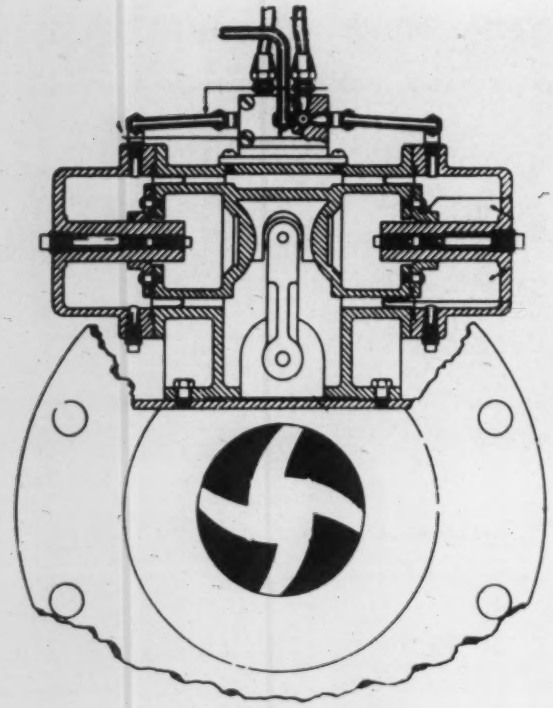


Fig. 5. Iris-type control valve and air-motor operator.

Control of Gravity Filter Beds

The next step is to process the clarified water through the gravity filter beds. This produces clear water with suspended solids content of 1 to 2 ppm. The filter beds collect all suspended material that may be carried over from the clarifier.

Each of the four filter beds, operating in parallel, is capable of filtering 1,260 gpm with minimum head loss under clean bed conditions.

The cleanest bed will pass the most water. Bed efficiency is controlled by equalizing the water passage through each bed. Two control elements are employed to achieve this condition—a filter-water flow control and a loss-of-head control. In addition to the individual control for each filter, a master control for all four beds is provided to maintain constant level in the clearwell (the basin that receives the water after passage through the filter beds).

The heart of the filter-bed control system (Fig. 4) is the flow-control valve and accessories. Water flow from each bed is metered prior to clearwell entry by use of an abbreviated, trumpet-type Venturi tube. A vane-type control valve, air-motor operated, is installed immediately downstream of the Venturi (Fig. 5).

Differential pressure across the Venturi is applied to a flow converter (upper left in Fig. 4) whose output is a controlled air pressure of 0-3 psig. The varying displacement of a bell-shaped weight in a mercury pool is used to make the control air pressure linear with flow. This control pressure is fed to one chamber of a double-diaphragm escapement assembly, which governs the loading air pressures sent to either end of the vane-valve positioning motor. The opposing chamber of the double-diaphragm escapement assembly can receive its control pressure from either of two sources—manual or automatic. If on automatic, control pressure from a bubbler-type level element in the clearwell is transmitted.

As a filter becomes fouled, the head loss across it increases and the flow rate declines, reducing the measured differential across the Venturi. The flow converter responds with a changed air signal, repositioning the vane valve to greater opening. Hence each filter maintains the same flow rate despite differences in head loss. Under manual control, the positioning motor is loaded by imposing a hand sender pressure. The control pressure generated by the flow converter is delivered also to a diaphragm-operated indicating gage, graduated in flow units.

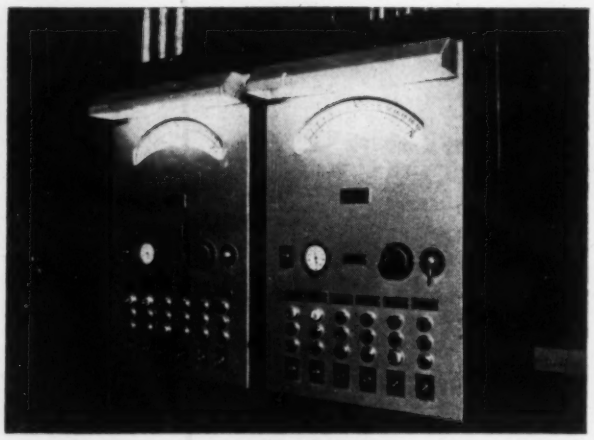


Fig. 6. Two filter-bed control panels.

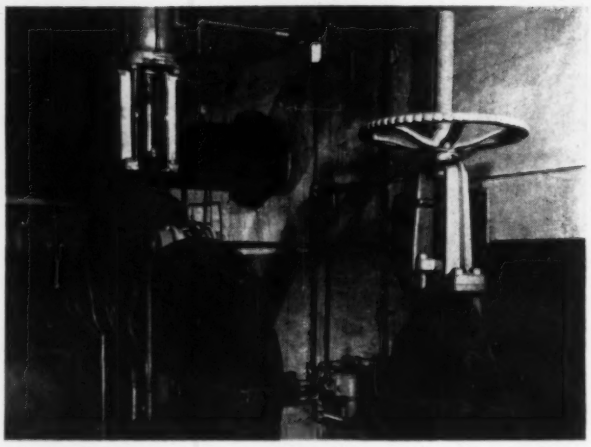


Fig. 7. Air-motor-operated gate valve controlled by solenoid valve.

Filter-bed head loss is determined by sensing the hydraulic differential between filter inlet and outlet, with correction for water leg, and applying the differential to the diaphragm chambers of a *loss-of-head converter*. The converter develops an air signal of 0-3 psig in proportion to the measured filter head loss. This controlled pressure is fed to a diaphragm-operated indicating gage, graduated in feet, as a measure of filter head loss. Fig. 6 is a picture of two filter-bed control panels.

Backwash

When a filter bed becomes fouled, as indicated by a head loss of 5 or 6 feet, the bed is removed from service and backwashed to clean it. This involves reversing the flow of water through the bed to dislodge and float away foreign deposits. To isolate a bed preparatory to backwashing, it is necessary to reposition several large gate valves. This done through air-motor-operated valving controlled by toggle switches mounted on the panel. Each switch excites a small electrical-solenoid air-valve to supply air power to the motor (Fig. 7).

It is necessary to control the rate of backwash water, beginning the backwash at a low flow rate and gradually

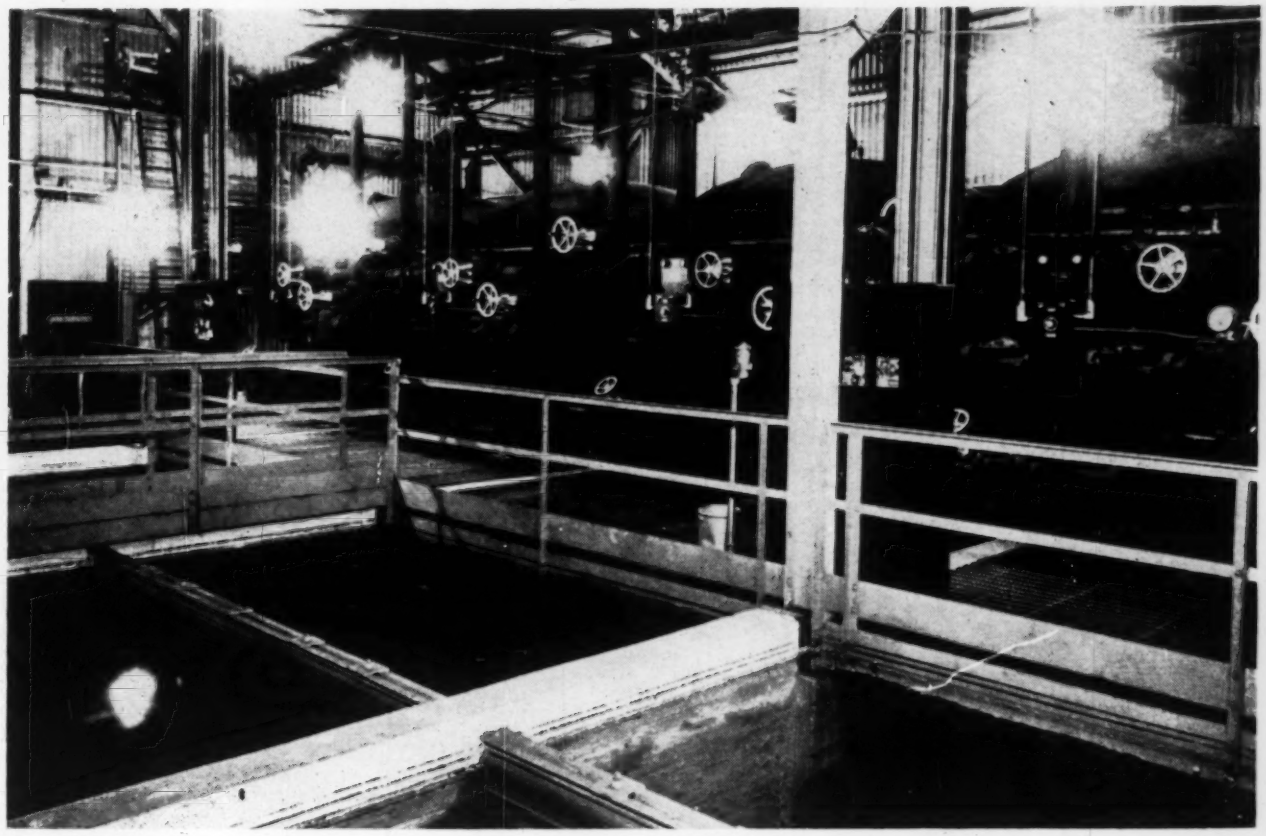


Fig. 8. Sodium-zeolite softening units.

increasing flow to about 4,500 gpm. To accomplish this, an air-operated flow-control valve is installed in a bypass around the backwash-pump discharge. Valve position is controlled by a panel-mounted toggle switch, which acts to energize a solenoid air valve to supply air loading pressure. Backwash water flow to a bed is metered. An indicating flowmeter is mounted above each pair of control panels for the operator's guidance while backwashing a bed.

Zeolite Softeners

Filtered water is next pumped from the clearwell to the sodium-zeolite softening units (Fig. 8), and then to the plant consumers. The softeners remove practically all calcium and magnesium hardness in the water. This equipment uses the same principles as common domestic-type softening units. In the exchange reaction, the two hardness promoting elements (calcium and magnesium) are displaced by sodium from the sodium-zeolite compound.

It is necessary to regenerate the zeolite bed when its sodium content becomes depleted—first by backwashing the unit, followed by introducing brine (a 10-percent sodium-chloride solution) through the bed, and concluded by rinsing the bed to remove undesirable chemical deposits precipitated by the action.

Operating Factors

The last column in Table 2 shows the chemical analysis of the softened water delivered to plant consumers. Where water is supplied to several consumers, flowmeters should be employed to provide equitable distribution of water. Fig. 9 shows the main flowmeter panel. It is mounted in the treatment-plant laboratory, and permits the plant operator to detect undesirable conditions that can arise in the plant system.

Production of quality water for steam generation is achieved only by a continuous checking of process-water analysis. The operator is required, on a two-hour schedule, to run tests on samples lifted from the clarifier, clearwell, and zeolite units, and to make adjustments as indicated. These include backwashing the filter beds and regenerating the softeners. The operating attendant performs analyses, also on a two-hour schedule, of boiler water samples taken from five 175,000-lb/hr boilers. In addition, he operates a large air-compressor station adjoining the treatment plant. The present degree of service is made possible by the instrumentation described.

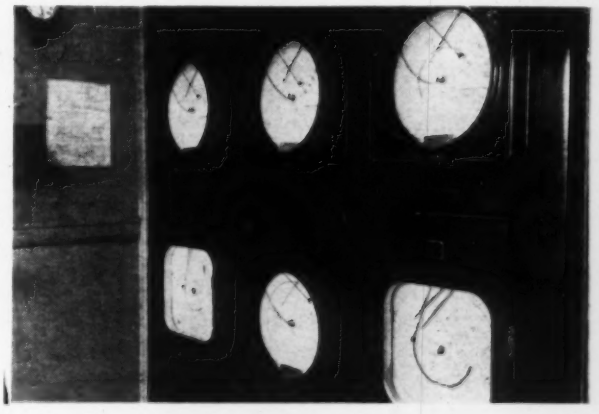
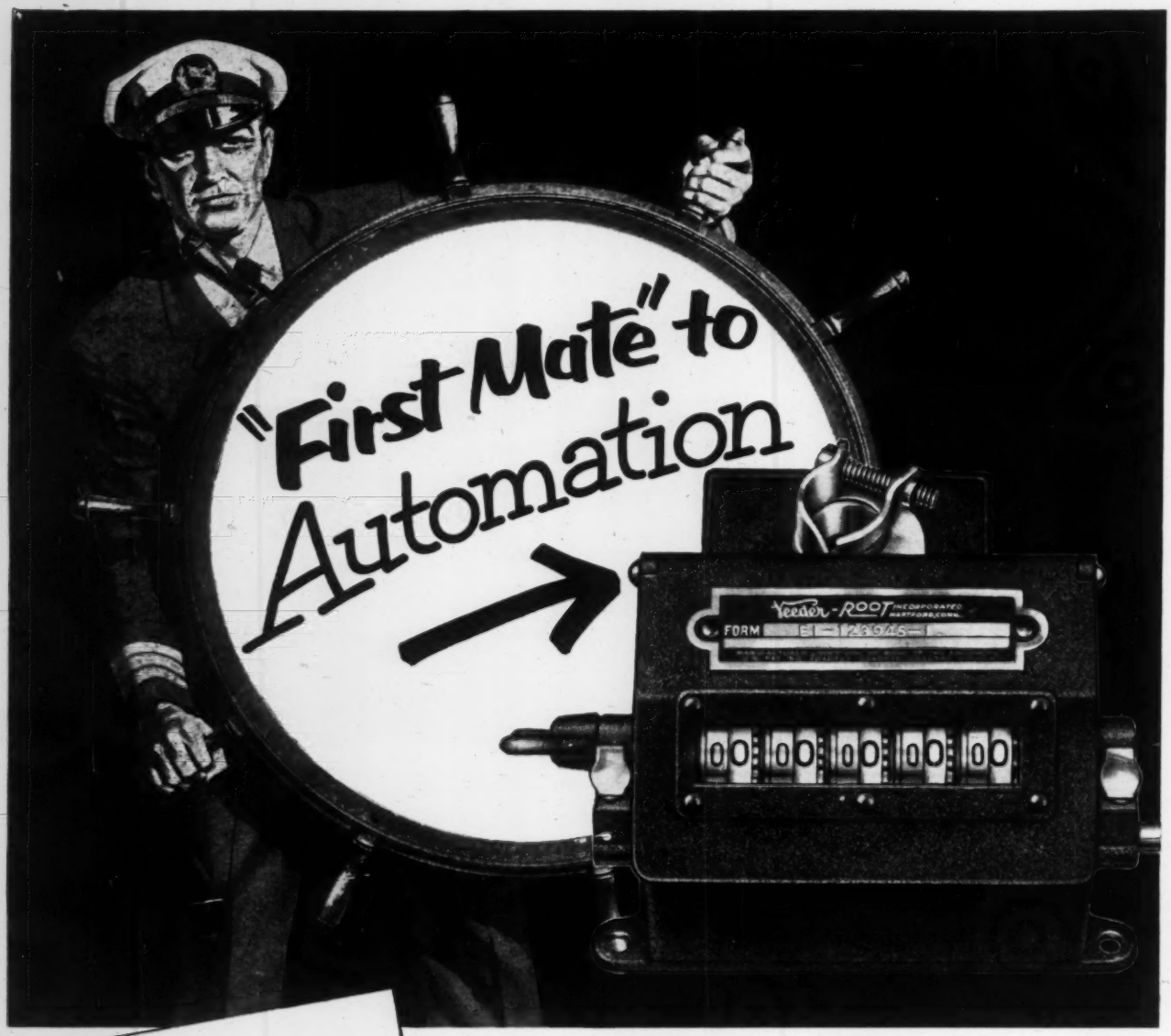


Fig. 9. Main flowmeter panel.



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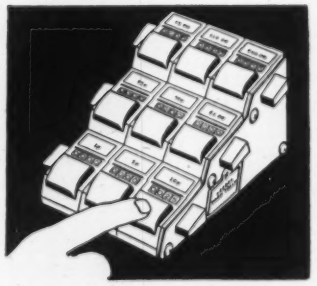

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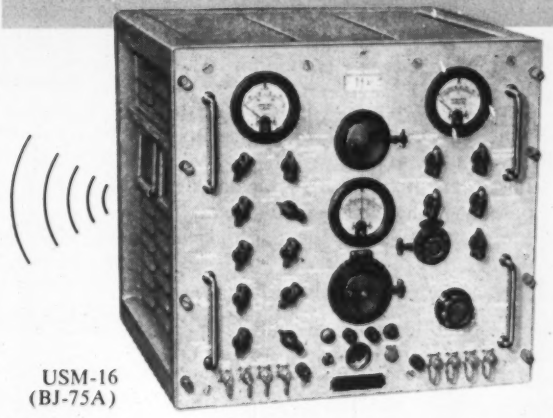

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Floatless Liquid-level Controllers

GARMAN O. KIMMELL, Kimray, Inc.

New developments have brought to the field some simple and versatile controllers of the non-bleed, non-throttling type. Though not presented as a cure for all liquid-level problems, they have a wide range of application in the oil industry. Construction, installation, and operation of a low-pressure and a high-pressure floatless controller of the differential-pressure type are discussed.

FLOATLESS LIQUID-LEVEL CONTROL at atmospheric pressure is not new. Spillways, overflow pipes, tank-shut-off valves, and altitude valves are all "floatless" in the sense that they do not employ a float or a displacement element. Even though many needs of industry have been met by controllers embodying such elements, floatless control of liquid level in vessels under pressure has attracted attention for many years; in 1949, experimentation with sensitive, non-bleed, pilot-operated backpressure regulators for low-pressure gas sparked the development of the floatless level control by Kimray.

Comparison of Float and Floatless Controllers

A comparison between float-operated and the floatless controllers is helpful in understanding the features of both types, particularly as applied to closed pressurized vessels.

The float is the sensing element in the float-operated controller; it must be in direct contact with both the liquid to be controlled and the gas above the liquid.

In the floatless controller, the level is sensed by utilizing the pressure difference between two piped connections made into the pressurized vessel—one into the liquid space in the vessel, the other into the gas space above the liquid. These two pressures are piped to the controller (Fig. 1) and applied to the two sides of the *pilot diaphragm*, which is the sensing element. As long as the liquid level in the tank remains between the two piped connections made into the vessel, the controller can respond to level changes. Dimensionally, the float equivalent (basic pickup force) in the floatless controller is a vertical cylinder with an effective diameter of the pilot diaphragm, and a height equal to the distance between the two connections made into the vessel.

Whereas the float must be located at the liquid level to be controlled, the floatless pilot can be mounted at any reasonable point below the liquid level.

Pressure Barrier

In the float-operated device it is necessary to transmit float motion from the inside to the outside of the vessel (referred to as "crossing the pressure barrier.") This is usually done in the low-pressure range by employing a trunnion and stuffing box. In the floatless controller (Fig. 1) the pressure barrier is crossed by employing two small diaphragms of equal areas called *balancing diaphragms*. The pressure of the gas in the vessel is cancelled out in the pilot because it is acting in opposite directions on equal areas. Liquid head acts on the upper side of the bottom balancing diaphragm, but a part of the main diaphragm is assigned to balance this head pressure. The effective area of the main diaphragm, therefore, is its total area minus the effective area of one of the balancing diaphragms.

If the floatless pilot of Fig. 1 were applied to a vessel, changes in liquid level would produce a perceptible movement of the diaphragm assembly (the cross-hatched area). If this assembly were held rigidly at its neutral point, the force produced by level changes would compare favorably with the force produced at the end of an external lever arm driven by an internal float.

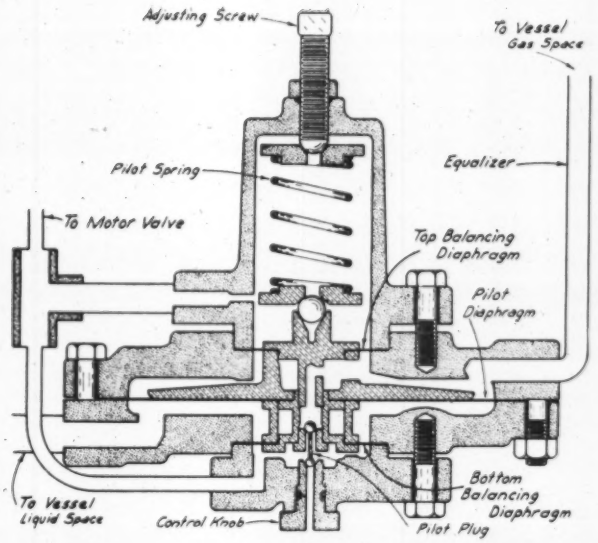

Fig. 1. Low-range pilot (125-in w.c.) for floatless level controller. Pilot has large pilot diaphragm assembly (cross-hatched), attached to small balancing diaphragms at top and bottom. Pressure from gas space in closed vessel is applied to top of pilot diaphragm. Static pressure caused by liquid head is connected to underside. Control knob at bottom provides adjustment for snap-action and/or throttling service. Gas-space pressure serves also as supply for operation of control valve.

Construction of Sensing Element and Pilot

As motion of a diaphragm varies its effective area, (decreasing when the applied pressure is increased), the pressure-displacement curve deviates from a straight line. Also, diaphragm travel is limited by the elastic properties of the material. These diaphragm characteristics necessitate a design such that the diaphragm-pilot element is a force translator, not a motion translator. Changing the pressure (due to level) to an equivalent force is accomplished by a simple three-way valve with two seats.

One of the seats is fixed to the moving diaphragm assembly; the other to a stationary housing below the bottom balancing diaphragm (Fig. 1). There is a definite position of the diaphragm assembly where the pilot plug closes both seats simultaneously.

When two diaphragms are tied together (as are the balancing diaphragms of Fig. 1), and the space between them is subjected to pressure, the assembly will assume a position in which the effective areas of the two diaphragms are equal. To displace such an assembly from this "pressurized neutral" point requires a force equal to the product of the sum of the changes in areas of both diaphragms times the applied pressure. As the position of the pressurized neutral cannot be predetermined exactly because of manufacturing tolerances, the seat in the housing is made adjustable by a knob.

Safe working limits for pilots have not been established, but trouble-free operation may be expected up to pressures within the 125-to-250-psig range. The gas pressure in the vessel is used for the pilot supply, thus the necessity for a supply regulator is eliminated.

Diaphragm-motor Valve

A cross-section of the control valve is shown in Fig. 2. To simplify mathematical considerations it is assumed

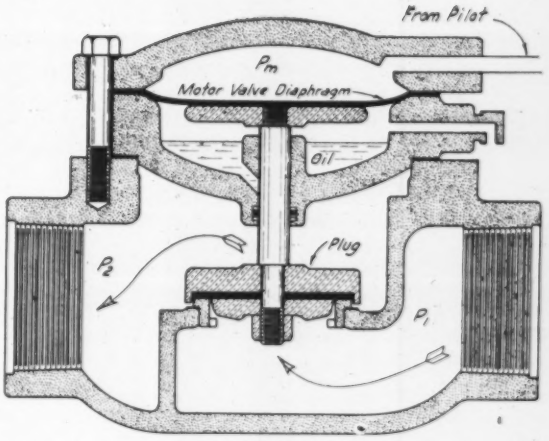

Fig. 2. Low-pressure diaphragm-motor valve features near-constant 2:1 ratio of diaphragm/plug area. Diaphragm pressure is function only of pressure drop across the single valve seat.

here that the ratio of the effective areas of the valve diaphragm and the plug remains constant at 2:1. Therefore, (referring to Fig. 2): $P_m = (P_1 - P_2)/2$, which shows that the diaphragm pressure is a function only of pressure drop across the single valve seat.

Operational Features

It may seem like a control paradox to use a pilot that is purely head sensitive and non-throttling with a control valve whose diaphragm pressure is a function of pressure drop only. However, a slight, obscured modulation does exist, due to the typical behavior of the diaphragms of motor valve and pilot, and due to the decreasing pressure drop across the motor valve plug as the valve opens. Ideally, the pilot would be perfectly sensitive except for the small unbalances existing across the seats of the pilot plug. Even though some sensitivity is lost by this unbalance, hunting (under all but the most severe conditions) is prevented by the slight modulation described, together with the damping action of the hydraulic system.

Snap Acting or Throttling Service is Possible

Adjustment of the lower seat of the pilot plug to a point where both seats of the plug are closed at the exact pressurized-neutral point of the diaphragm assembly readies the pilot for throttling service. This point is determined during assembly and can be set by screwing the control knob in to its limit. Level control of less than one inch can be expected, even under varying flow conditions, with the pilot set for throttling. If the simultaneous setting of the pilot plug occurs at a point below the pressurized neutral, an unbalance exists in the pilot which varies with

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(1) the deviation of the simultaneous seating point from the pressurized neutral, (2) the pressure in the system, and (3) the pressure drop across the motor valve. Small unbalances in the pilot will cause slight hunting. Large unbalances, produced by unscrewing the control knob as much as half a turn, will cause snap action of the pilot. For the average installation, an approximate relation between pressure, snapping range, and position of the control knob is given by the simple expression:

$$S = PT/4$$

where S = snapping range in inches of head (minimum is 2 to 3 inches), P = pressure in the system in psig, T = number of full turns of control knob from neutral.

Installation and Application

The pilot may be mounted directly on the vessel or at a remote location. Remote mounting is limited by friction in the connecting piping, which affects the desired speed of response. The pilot should be mounted between 6 and 42 inches below the desired liquid level.

Location of the liquid-tap connection to the vessel is important. The tap must be free of any pressure effects which the pilot will sense as head. For example, connection of the pilot to a flow line from the vessel must be avoided if the head loss between the vessel and pilot at maximum flow is greater than a fraction of an inch. A tap provided on the side of the motor valve for mounting the pilot should be used only where the pressure drop between the vessel and motor valve is low. Most low-pressure vessels use gage glasses for simple indication of level. Mounting the pilot on a tee in the bottom connection of the gage glass is satisfactory.

Equalizer connections to the wrong point of the gas space in the vessel have been a source of trouble with the floatless pilot. Except in the case of liquid storage, liquid level usually involves separation of liquids (by separators with internal baffles) which produce pressure gradients. It is imperative that no extraneous pressure drop be imposed across the pilot. Consequently, the equalizer connection must be made to a point on the separator at which the gas pressure is the same as in the liquid chamber, and not downstream from baffles or mist extractors. A properly connected pilot is capable of controlling the liquid level in a vessel of almost any diameter. A four-inch diameter is not unusual; a two-inch diameter is possible though not recommended.

A complete floatless controller, comprising low-pressure pilot and motor valve, has a working pressure range from 5 to 125 psig. The lower pressure limit is the minimum necessary to operate the motor valve properly.

The upper limit of operating temperature varies widely with conditions. The large radiating surface of the pilot causes it to operate close to the ambient temperature. Component parts in the pilot will withstand temperatures to 200°F. The limiting factor in most cases would only be an excessive amount of condensation in the equalizer line where equilibrium conditions exist in the gas space of the vessel. The lower temperature limit is well defined by the behavior of the liquid at the minimum temperature encountered. For example, water would freeze in the pilot at temperatures below 32°F. With few exceptions, a low-temperature installation can be considered safe if the minimum temperature does not drop below the vessel temperature. (In this event the gas in the equalizer line is superheated and causes no trouble, and the liquid below the pilot diaphragm cannot freeze if its temperature is higher than that in the vessel.)

Solids suspended in the liquid do not impede operation of the floatless controller. They are less likely to collect on the pilot than on a float. Plugging of the liquid line presents the only problem. Paraffin forms a special case because it tends to build up on any surface. In less severe cases of paraffin deposition, satisfactory operation is possible by using a "stinger" in the liquid connection which extends into the center of the vessel. In severe cases of paraffin deposition, the floatless controller is not recommended.

Unusual liquid-level control problems have been solved by employing a sealing medium between the pilot and the liquid to be controlled. To illustrate the simplest use of such a liquid transfer medium, let us assume that a hydrocarbon liquid, water, and gas are flowing into a separator. Unless the water is otherwise controlled, its level will establish itself at the elevation of the liquid outlet. If the characteristics of the hydrocarbon liquid present a level-control problem, liquid connection of the pilot can be made in the water region. The pilot can then be set to compensate for the constant head of water and to control the head of hydrocarbon liquid above it. A special pot containing any liquid which would not mix with the liquid to be controlled, and of a higher density, can be substituted for the bottom portion of the separator used in this example.

The floatless controller requires no more than the usual care given to any pilot-operated device. One precaution, however, should be mentioned which is not required when using float units because the pilot diaphragm is not in direct contact with the liquid and the gas space, and the resistance of the connecting piping varies with the flow. The pilot has to be readjusted when again connected to a vessel which has been serviced. If valves are installed in the connecting piping, a by-pass should be provided and the pilot handled in the same manner as an orifice meter. Danger of rupturing a pilot diaphragm by excessive pressure drops exists (much in the same manner as mercury might be blown from an orifice meter by the same cause).

Construction and Operation of High-pressure Pilot

Three factors make it impossible to apply the simple low-pressure-pilot principle to the high-pressure range: (1) Flexibility of the balancing diaphragms imposes a pressure limit. (2) The pressurized neutral becomes increasingly "rigid" as the pressure goes up and the sensitivity is lowered. (3) High vessel-gas pressure cannot be used for pilot supply. By crossing the pressure barrier in a different manner and providing a regulated pilot supply source, these limitations are overcome.

Fig. 3 shows a high-pressure pilot embodying the changes. Motion and force of the pilot diaphragm is not directly imparted to the pneumatic element, but is transmitted to the outside of the housing by means of a "waggle arm." The waggle arm is sealed by an "O"-ring and the sealing point becomes the fulcrum. The hydrostatic force exerted on the internal end of the waggle arm is resisted at the point of seal by a pivot bar. In operation, the pivot bar does not move. This eliminates any force couple and permits almost frictionless transmission of movement across the barrier.

A turnbuckle, capable of absorbing override in either direction under excessive load, connects the external end of the waggle arm to a tangent arm. The turnbuckle affords adjustment of the waggle arm to a neutral position with an equal amount of travel above and below the pivot bar, but should not be used for changing the liquid level. Reversal of operation of the pilot and adjustment of proportional band is effected by turning the upper end of the turnbuckle. The tangent arm loads the primary pneumatic pilot, which is a non-bleed-type force-to-pres-

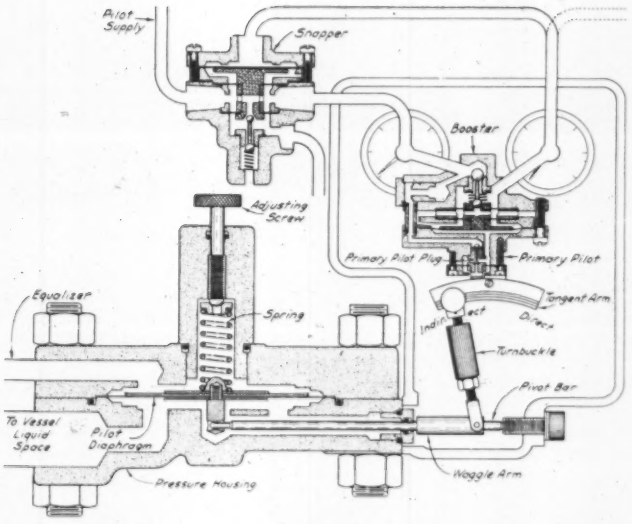

Fig. 3. High-range pilot is suitable for use up to 4,000 psig. Controller uses separate pilot supply, and no balancing diaphragms as in low-pressure unit. Motion transmission is by sealed pivot bar, waggle arm, turnbuckle and tangent arm to primary pilot. Primary pilot is connected to a pressure booster which operates diaphragm-motor valve directly (for throttling action) or via snapper pilot (for snap-acting control).

sure translator. In construction and operation, the primary pilot is similar to a miniature, direct-acting pressure-reducing regulator equipped with over-pressure relief. The tangent arm loads the pilot in the same way as the adjusting spring loads the regulator. After each change in signal pressure, the tangent arm returns to the same position at which both seats of the primary pilot plug are closed. The force produced by the non-bleed primary pilot is in opposition to the varying pressure caused by level changes, and it prevents hunting by imparting modulation to the system.

The pressure signal from the primary pilot is fed into a typical pneumatic booster. The signal from the booster can operate a motor valve directly for throttling control, or can be applied to a "snapper pilot" which supplies a positive on-off pressure to the motor valve.

Special Applications

Let us consider a level-control problem involving control of the interface between two liquids. Assume that the motor valve, operated by a pilot, requires 12-psi diaphragm pressure (between its closed and open positions), that the phase-density difference of the liquids is 62.4 lb/cu ft (the apparent specific gravity is 1.0), and that the pilot has a proportional band of one-half to two inches and a snapping range of one-quarter to one inch, (depending on the position of the turnbuckle slide on the tangent arm).

Even though this proportional band is not as narrow as claimed for many of the displacement-type level controllers, it is sufficient for satisfactory control of interface in most applications. Expected proportional band for interface control will be the given values divided by the apparent specific gravity.

Control of interface can be accomplished either by the total head or by differential-head method. If the level of the lighter liquid is held constant (preferably by flowing over a weir or other means), the pilot can control the interface by integrating the constant head and maintaining its average apparent specific gravity. In this instance the equalizer connection is carried to the vessel gas space, as described for low-pressure applications.

For control by differential head, the equalizer line is connected to the vessel at a point below the level of the lighter liquid so that the lighter liquid can keep the equalizer line filled, and the top side of the pilot diaphragm flooded, at all times.

Another interesting application for the pilot is the control of liquid level in a hot equilibrium vessel when condensation in the equalizer line is a source of trouble. In this case, the equalizer line is made larger and has a horizontal run from the vessel. Thus the vertical portion of the equalizer line is permitted to fill with liquid while condensation in the horizontal run will return to the vessel. The liquid and gas equalizer connections, and the action of the pilot, are reversed. The pilot thus operates on a head change—which is the difference between the constant column of condensate and the active head of liquid in the vessel.

The problem of approaching phase identity is associated with liquid level control at high pressures. At high pressure the liquid and gas phases approach each other in physical properties. Even at 4000 psig, phase-density differences as low as 12 lb/cu ft (corresponding to an apparent specific gravity of 0.2) have been observed on well effluents.

Conclusions

Though designed primarily for field use on oil and gas separators, many unique and successful applications to other equipments have been made. The problem of supply-gas failure due to freezing or contained foreign matter is solved by the use of non-bleed pilots which greatly reduce the volume of supply gas required. No fixed orifices are in the circuits, and the opening and closing of the non-bleed valves tend to keep the pneumatic path open. The floatless principle can be applied to elaborate instruments for a wide range of special applications.

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INSTRUMENTS and AUTOMATION

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Laboratory Standard Instruments

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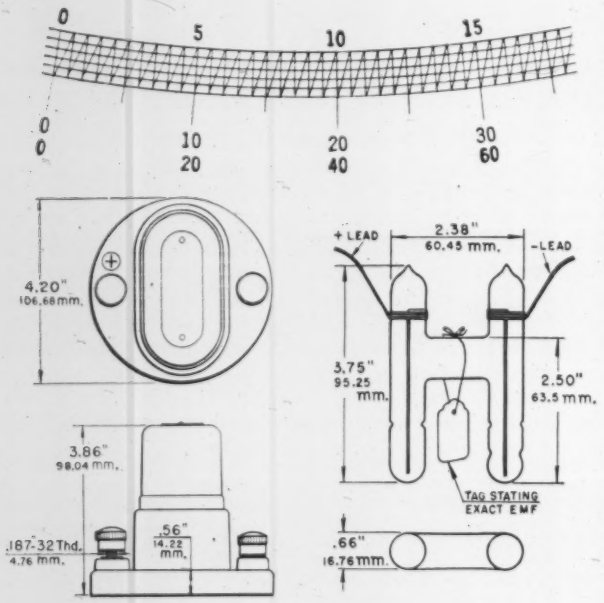


degree of accuracy . . . Rated accuracy (of Models 5 and 326 voltmeters, ammeters and wattmeters) is 0.1% of full scale value. The scales are hand-drawn into 100 or 150 major divisions, with each division subdivided into fifths for maximum accuracy in reading.

Weston Standard Cell, Model 4 Type 3, is the unsaturated form of cadmium cell. A laboratory standard of reference for the volt, it is intended for use primarily in conjunction with a potentiometer for measurement of current and voltage. EMF is between 1.0188 and 1.0198 absolute volts; temperature coefficient is in the order of 5 microvolts per degree centigrade or less; no current greater than 100 microamperes should be drawn from it. Accuracy is ±0.01% (from 4 to 40°C).

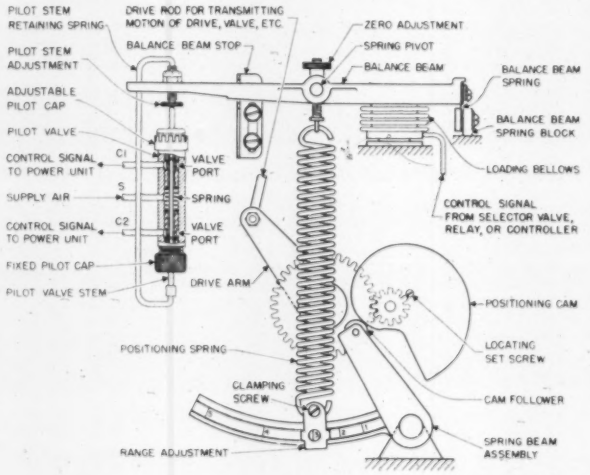
Commercial standard cell Model 3 Type 4 is smaller and furnished unmounted. EMF is within 0.0188 to 0.0198 absolute volts; accuracy is ±0.1% from 4 to 40°C.

The Weston Model 3 Type 7 Normal Cell is the saturated type of cell intended for use under controlled conditions as a primary standard of reference for the volt . . . it is customary to hold their temperature near 30°C by oil or air bath . . . transportation is by messenger . . . Legal voltage, by international agreement is 1.018636 absolute volts at 20°C . . . Accuracy is better than ±0.01%. (*From new 8-page brochure "Laboratory Standard Instruments," Weston Electrical Instrument Corp., Newark 5, N. J.*)

For this literature circle **601** on inquiry card.

Pneumatic Transmitter (Positioning Relay)

A positioning relay (1) positions a pneumatic power unit precisely—in linear or nonlinear relation to a pneumatic signal by translating it into a control signal which corrects for undesirable characteristics of the final control



element; or, (2) develops a pneumatic signal in a predetermined relationship to the position of a regulating device or movement actuated by external force.

The relay consists of (1) balance beam, (2) loading bellows applying force to balance beam in response to pneumatic signal, (3) spring applying variable load to balance beam through cam and linkage, (4) pilot valve producing pneumatic control signal (from change in either pneumatic signal from controller or position of drive rod). A 0.065 psig change in pneumatic signal will move pilot valve through full travel, delivering pneumatic output signal of 3-27 psig. (*From new 4-page brochure P99-5, Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio*).

For this literature circle **602** on inquiry card.

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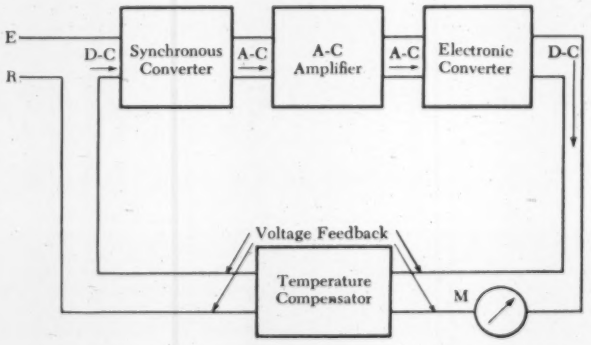

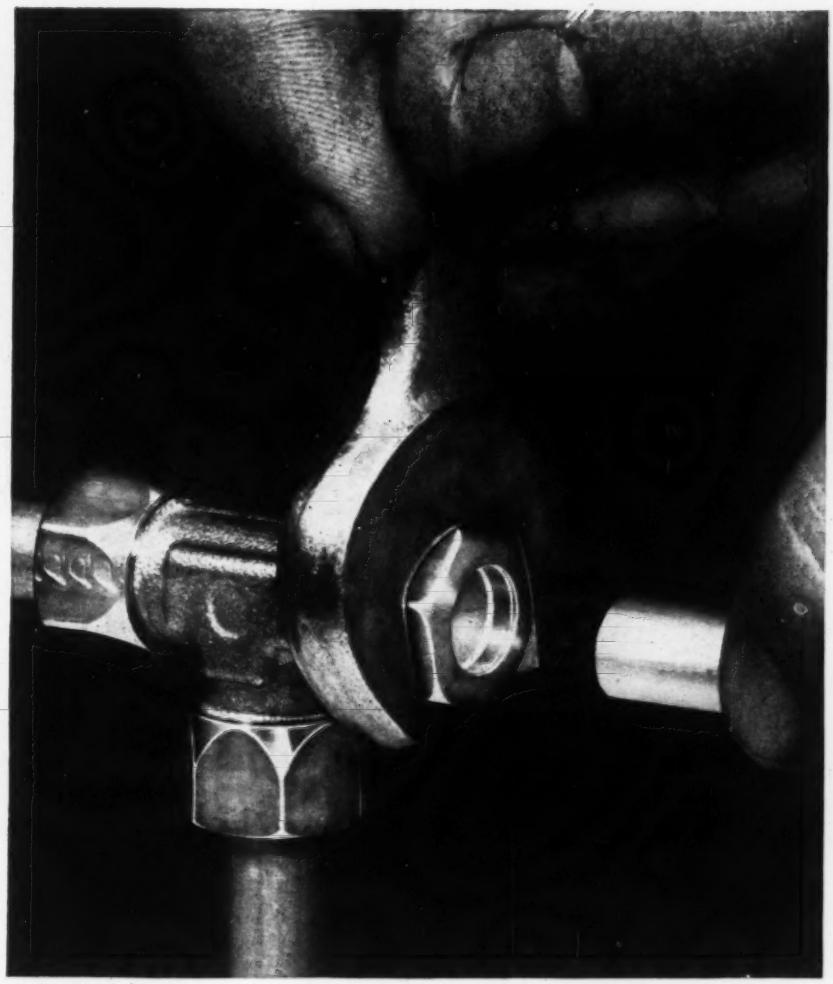

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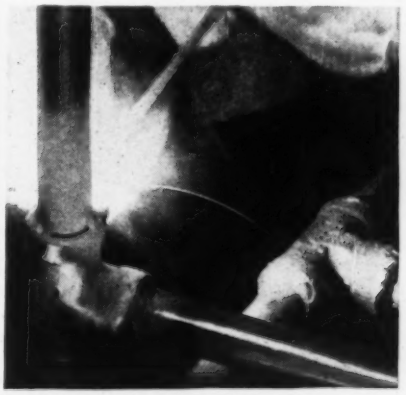

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0-±700 mv d-c; 0 to ±1400 mv d-c. Scale readability is 0.02 pH or 1 mv on 700 mv range.

For stable operation, this a-c indicator employs a converter-amplifier type circuit (see diagram). The use of a-c amplification stabilizes zero; d-c feedback stabilizes gain. The emf produced by the electrodes is first converted into a-c . . . then amplified . . . then converted into d-c and compared to the input voltage in a feedback circuit. The difference between the input and feedback voltages is so small that feedback voltage is a reliable index of input voltage. (*From new 4-page brochure E-96(2), Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.*)

For this literature circle **603** on inquiry card.

Rheology

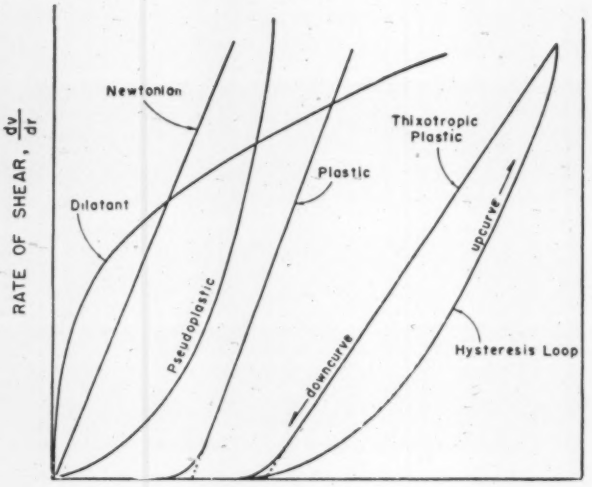
Rheology is the science of deformation and flow of matter . . . Before any description of techniques and apparatus for measurement measuring flow properties can be undertaken, it will first be necessary to define the various types of flow.

Types of flow (include) Newtonian flow; plastic flow; pseudoplastic flow; dilatant flow; thixotropic flow.

The most common type of rotational viscometer consists of two concentric cylinders with the test material located between them. The outer cylinder is in the form of a cup and the inner cylinder is solid and called a bob. Either the cup or bob may be rotated. The shearing stress per unit area is measured as a torque developed on the stationary member.

Poise: Unit of viscosity. A material has a viscosity of 1 poise when a shearing stress of 1 dyne per sq cm will induce a unit rate of shear.

Rate of Shear: The velocity of one plane with respect to another divided by the distance between them. The unit



of rate of shear is reciprocal seconds. (*From new 20-page booklet "Rheology in Paper Coating," by R. N. Thompson, Hagan Corporation, Pittsburgh 30, Pa.*)

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Thermoswitches

Thermoswitch (reg. trademark) controls are constructed with two silver contacts mounted on, but electrically insulated from, curved nickel-iron struts of low expansion coefficient. This element assembly is mounted under tension or compression in a seamless drawn-brass or stainless-steel tube. The amount of tension or compression is variable, depending on the position of the adjusting sleeve and temperature of the shell. . . . Changes in temperature

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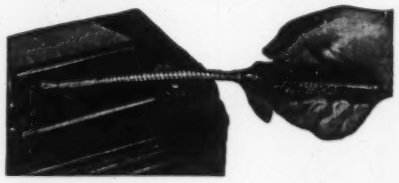

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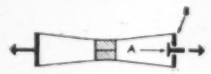
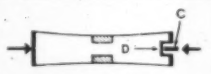
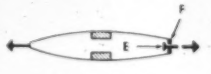
Schematic Diagram 4 Types Elements	Type Element Assembly	Switch Operated By
 Contacts Closed	Regular	Tension
 Contacts Open	Regular	Compression (Special Feature 37)
 Contacts Open	Inverse	Tension
Contacts Closed	Inverse	Compression (Special Feature 37)

cause the shell to expand or contract, causing the contacts to make or break.

Tension-operate units may be subjected to . . . 100°F above the set point or any temperature below the set point without damage to element. Controls have a maximum current rating of 10 amps at 115 v ac; 5 amps at 230 v ac. Inherent sensitivity (smallest temperature change to open or close contacts) is less than 0.1°F. (*From new 52 page Catalog 400, Fenwal, Inc., Ashland, Mass.*)

For this literature circle **605** on inquiry card.

Valve Selection Chart

To select proper valve size from the approximate maximum flow desired, you need to know:

for liquids:

q = liters per minute of liquid flow
G = specific gravity of the liquid (water = 1)
h = pressure drop through valve in psi

Substitute in the formula

$$C_v = q\sqrt{\frac{G}{h}}$$

Use calculated C_v to select valve orifice size from following table:

C_v (l/m)	Orifice size (inches)
0.25	.059
0.42	.0625
0.62	.086
0.70	.125
1.00	.125*
1.40	.141
1.60	.170
1.80	.219
2.50	.250
5.60	.313

for gases:

q' = cubic feet per hour of gas flow
G' = specific gravity of the gas (air = 1)
h = pressure drop through the valve in psi
P = upstream pressure of the gas in psia
t = temperature of the gas in degrees F

Then substitute in the formula

$$C'_v = \frac{q'}{1360}\sqrt{\frac{G(460+t)}{hP}}$$

Use calculated C'_v to select valve orifice size from following table:

C'_v (cfh)	Orifice
15	.059
20	.0625
25	.125
40	.125*
60	.141
80	.188
100	.219
140	.250
200	.313

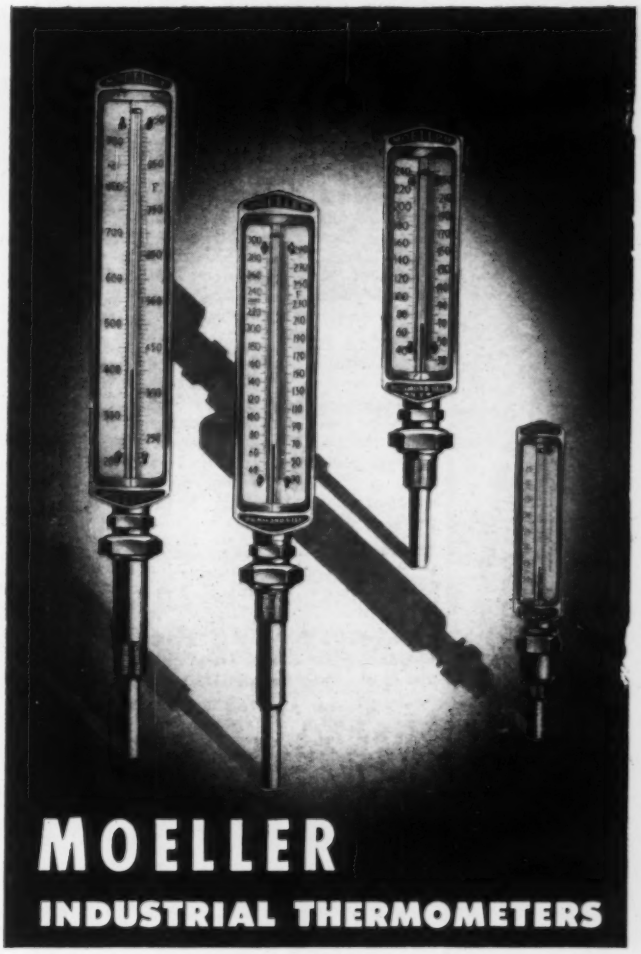
* Applies to metering valves only.

(*From new 18" x 24½" wall chart offered by Hoke Incorporated, 148 S. Dean St., Englewood, N. J.*)

For this literature circle **606** on inquiry card.

Electronic AC Wattmeter and RMS Volt-ammeter

The conventional dynamometer type of AC wattmeter produces a pointer deflection which is a function of the average power fed into a load circuit. This deflection is usually not exactly proportional to the power, resulting in some scale crowding. The power lost in the meter movement is substantial and the frequency range is limited. If the power is to be recorded by a direct writing oscillograph further complications arise. A wattmeter recording meter movement consumes even more power than an indicating instrument, is relatively sluggish in response, and is not



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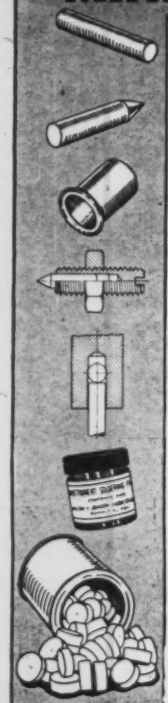

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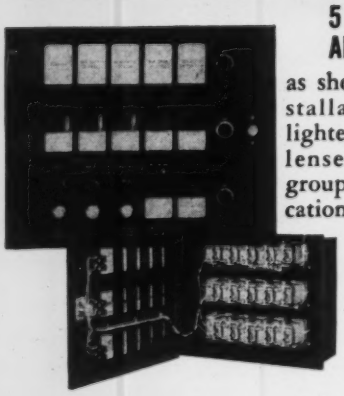

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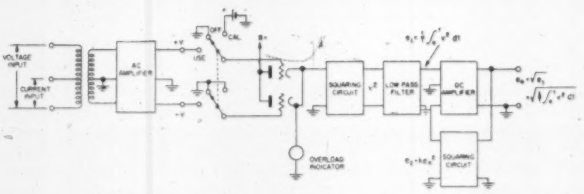


easily combined with other direct writing recording channels for simultaneous recording of other quantities.

Similar considerations apply to the measurement and recording of the RMS value of AC voltages and currents.

These limitations could be overcome if the average value of AC watts, and the RMS value of AC voltage or current, were converted by some means into a DC voltage proportional to the AC quantity being measured. This converter, of course, should be capable of operating over a broad frequency range and with a low power drain from the circuit being measured. The resulting DC voltage could then be read or recorded by any of the many indicating and recording instruments available for DC measurements, such as Sanborn Oscillographic Recorders.

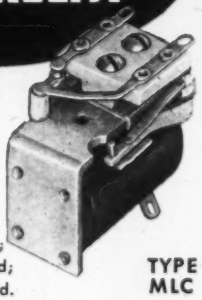
It is the purpose of this article to describe two converters, one of which provides a DC voltage proportional to the average value of power in an AC circuit, while the other produces a DC voltage proportional to the RMS value of an AC voltage or current. (*From May, 1955 8-page issue of "Right Angle," Sanborn Co., Cambridge 39, Mass.*)

For this literature circle **607** on inquiry card.

Thermostat Metal

An increasing number of products are made in which heat generated by the passage of electric current through

NEW MINIATURE *Low Capacitance* SWITCHING RELAY



• **Low Capacity Blades for High Frequency Switching**

• **Switches Mounted on Ceramic Separators**

Capacitance (with 1 Form "A" switch):
Capacitance between open contacts .75 mmfd;
Capacitance between closed contacts 2.0 mmfd;
Capacitance from contact to ground 1.25 mmfd.

TYPE MLC

Coil Resistance: Up to 6500 ohms (No. 44 AWG wire).

Contact Rating: 3 amps. @ 28 VDC max. Suitable for low level audio or r.f. loads. Contact material dependent on application.

Contact Combination: Standard, up to 1 Form "C".

Shock: Meets requirements of MIL-R-5757B.

Vibration: 10G up to 500 CPS.

Send For Details

Size: 23-32 W., 1 1/16" L., 1 3/16" H. with 1 Form C.

Applications: For guided missiles, h.f. communications equipment, etc.

Comar ELECTRIC CO.
3349 ADDISON STREET
CHICAGO 18, ILLINOIS

RELAYS • SOLENOIDS • COILS • TRANSFORMERS • SWITCHES • HERMETIC SEALING

For more information circle **150** on inquiry card.

● **FREE DEFLECTION**

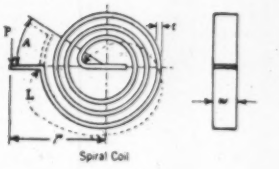
$$A = \frac{c_1(T_2 - T_1)L}{t}$$

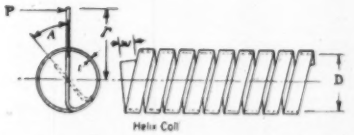
● **FORCE**

$$p = \frac{a_1 A w t^2}{Lr}$$

● **RESTRAINED FORCE**

$$p = \frac{a_1 c_1 (T_2 - T_1) w t^2}{r}$$





a thermostat metal element operates the device. These applications require a preferred sequence of thermostat metals covering a wide range of electrical resistivities. . . . Truflex Thermostat Metals are manufactured in such a sequence, having a resistivity range of 20 ohms to 850 ohms per circular mil foot in graduated steps.

The formula for the heating effect of an electric current is:

$$H = \frac{I^2 rt}{4.18}$$

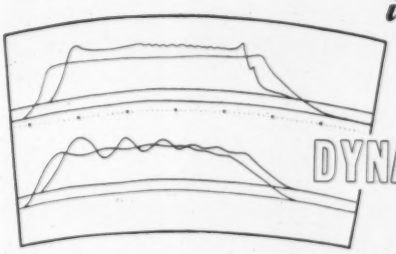
where H = heat, calories; I = current, amperes; r = resistance, ohms; t = time, seconds. . . . Other useful formulas (discussed) include . . . the free thermal bending formula, force and/or torque formulas. (*From new 70-page Catalog PR750, Metals & Controls Corp., General Plate Div., Attleboro, Mass.*)

For this literature circle **608** on inquiry card.

Regohm Regulators

(Finger-type regulators have a coil in which the current controls the number of fingers making contact, thus controlling the resistance of the element.) In the Size 1 and Size 3 Regohms, with 10 and 20 standard fingers, the op-

instruments for DYNAMATION



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For more information circle **152** on inquiry card.

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REPRESENTED IN USA
BY HEINZ W. HOPF
527 LEXINGTON AVE
NEW YORK 17, N.Y.

For more information circle **151** on inquiry card.

MARSH MAKES IT!

If it's a pressure gauge or dial thermometer, Marsh makes it . . . and makes it better. The types, ranges and case styles are endless. What is "special" to other instrument makers is often standard to Marsh. To know the scope of Marsh instruments—

Write for this fact-filled catalog

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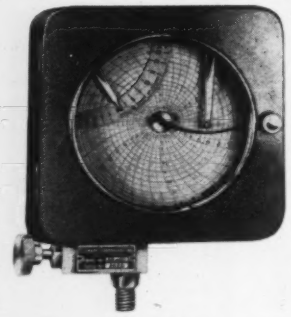
Dept. 42, Skokie, Ill. *Export Dept.*, 3501 Howard St., Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alta.

For more information circle **153** on inquiry card.

Reduce your Argon welding Costs . . . . with the new

ELEMATIC



Indicating and Recording Flowmeter

Elematic Flowmeters are specifically designed to give an accurate record of argon gas or oxygen flow for controlling and determining cost. They are adaptable to a regulated cylinder supply or a piped system.

Individual job billing costs can be charted. Quick check of welding apparatus efficiency is provided at all times. Insufficient flow can be immediately detected. Flow is permanently recorded for 24-hour or lesser periods on an easy-to-read chart.

Gauges available in two sizes: with 4½" chart from 0-15 LPM to 0-100 CFH; with 10" chart from 0-25 to 0-300 CFH. Both models are supplied for operation at approximate inlet pressures of 20 or 50 PSI, depending on specification.

Applications:

Manual or mechanized shielded inert gas arc welding equipment: Heliarc, Heliweld, Sigma, Aircomatic, Fillerarc

Features:

Easily installed and operated. Minimum maintenance. Non-lubricated. Self-contained ink reserve. On-off time recorded.

Send now for Bulletin AR-1.

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ROLL TEST THEM RAPIDLY ACCURATELY with the

SCHERR 5" FINE PITCH GEAR TESTER

So economically priced they can be placed alongside each Gear Cutter as well as in the Inspection Dept.

COMPLETE WITH HIGH CENTER ATTACHMENT..... **$425**

Quickly reveals Runout in Pitch Line, Spacing Errors, Errors in Tooth Form, Running Quality Generally.

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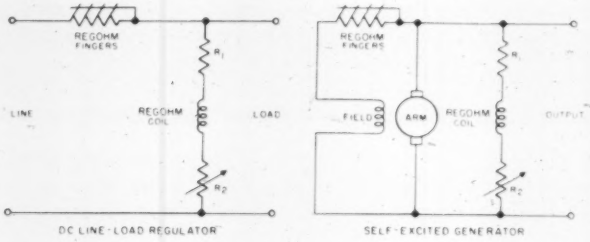


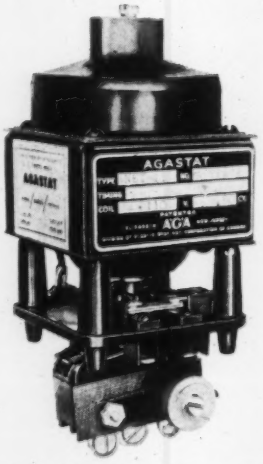
erating coil power is one watt. In the size 4 Regohm, with 60 fingers, the increased total finger tension and greater armature travel require an operating coil power of 3 watts. It must be remembered that this is the bias power . . . and that the differential or error signal power required by the operating coil is of the order of milliwatts over the entire control range. To reduce effects of coil heating, the coil should be connected in series with a temperature-stable resistor of at least 7 times the coil resistance. . . . Typical applications are shown. (*From new 8-page Bulletin* 6.04, *Electric Regulator Corp., Norwalk, Conn.*)

For this literature circle **609** on inquiry card.

Laboratory Standard Instrument

The Laboratory Standard Dynamometer Polyranger (features): accuracy of 0.1%; period of 1.5 seconds; ac milliammeter readings down to 1 ma and up to 500 ma; ammeter scales up to 10 amperes; voltmeter readings down to 1 volt and up to 500 volts; anti-parallax mirrored vernier scale.

Use of the vernier scale principle is illustrated. In A,



Staggered starting of electric motors...

AGASTAT

Time / Delay / Relay

AGASTAT allows you to stagger the starting of three motors without imposing their load on the line at the same time.

The AGASTAT is

- electrically actuated, pneumatically timed.
- light, versatile, dependable.
- instantaneous recycling.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in AC or DC models which offer delays on energizing and de-energizing, manually-actuated time delay switch, remote push button control, hermetically-sealed units.

Write our application engineers for help with your timing problem. Address Dept. A 25-109.

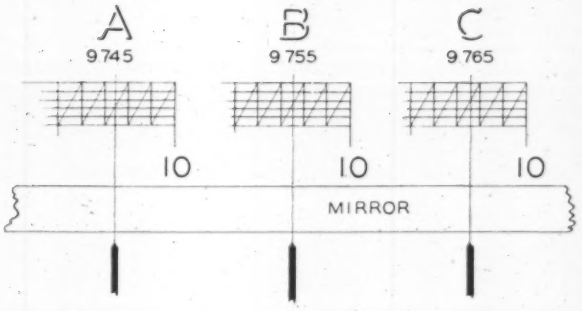
AGA DIVISION

Elastic Stop Nut Corporation of America

1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in pneumatic timing.

For more information circle **156** on inquiry card.



pointer is ¼ distance between the 0.04 and 0.06 crossover, and reading is 9.70 + 0.04 + 0.005 = 9.745. In B, the pointer is ¾ of the distance between the 0.04 and 0.06 crossovers, and reading is 9.755. (*From new 4-page Vol. 22, No. 3 issue of "Electrical Measurements," Sensitive Research Instrument Corp., Mount Vernon, N. Y.*)

For this literature circle **610** on inquiry card.

Rapromatic Camera-Processor-Projector

Three instruments in one, the Rapromatic 4000 is a high-quality camera, processing machine, and projector/magnifier. The unit takes, produces, and projects high-definition pictures in *seconds*.

In the illustration shown, the Rapromatic is focused on an oscilloscope, takes a picture of a transient that exists for less than 1000th of a second, and a picture of the trace is projected on the screen.

The Rapromatic is a powerful multiplier of light. When images are too dim to be seen, the instrument will photograph and immediately project a picture a thousand times brighter than the original. . . . 200 foot roll of 35-mm film

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Designates
MACHINE
FINISH

CONTROL OF SURFACE QUALITY—Stepped-Up production . . . Increased Efficiency . . . Reduced Rejects—These are the results that can and ARE being realized EVERY DAY through the adoption of the Surf-Chek method of Designation and Quality Control.

KIT INCLUDES—60 page instructional text and molded Surf-Chek Roughness Standard replicas of 24 surfaces, 4 to 500 micro-inches. Turning, grinding, milling, honing, lapping and polishing can now be definitely controlled. Thousands in use. Write for 4-page folder B.

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★ Hollywood 28, California ★

SCANDINAVIAN AGENT: C. E. Johansson, Eskilstuna, Sweden

For more information circle **158** on inquiry card.

PRESET COUNTERS

Automatically count and control to 1,000,000 events.

Dual and multi-sequence models available to provide output signals and relay contact closure at any two or more preset totals

FEATURES
Absolute Accuracy
High Speed
Reliable
Automatic
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Economical
Small Size

Model DS-8600 Series (5 Models)

Designed to control any operation after a preselected total count has been reached. Used to count pills, bottles, cans, machine parts, etc. for automatic packaging. If an event can be converted to an electrical impulse, it can be counted and controlled with a Detectron Preset Counter.

Count Capacity: 100 to 1,000,000 (depending on model); **Counts per second:** 0-100,000 (as a straight counter); **Recycling rate:** 35,000 per sec. (as a preset counter); **Input Sensitivity:** 0.1 V RMS; **Output Signal:** 50 volt positive pulse; **Relay Contacts:** 5 amps., 115 v. 60 cycle, non-inductive load.

WRITE FOR COMPLETE DETAILS

Visit Us in Booth 424—Navy Pier Automation Show—Chicago

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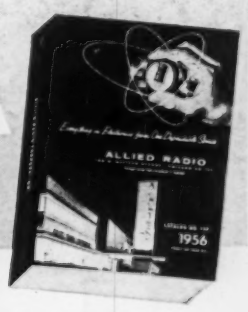

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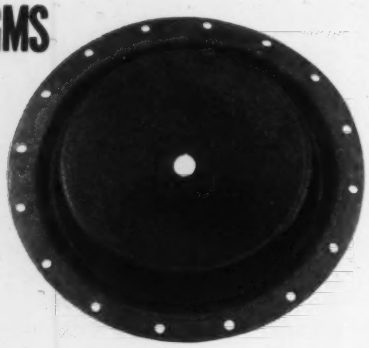

Haartz-Mason supplies constant finished thickness, surface smoothness and precision molding. You may select any one of twenty coated fabrics in various thickness using the finest types of nylon or cotton inserts. We manufacture the synthetic rubber coated fabrics which are used in these molded diaphragms. Thus you are assured of complete quality control through every phase of manufacture.

Haartz-Mason diaphragms may be engineered by the proper selection of fabrics to give desired finished properties. Such as flexibility, high and low temperature properties, aromatic resistance and good flange sealing.

Diaphragms are manufactured to customer's specifications. Molding experts give them careful attention and guarantee prompt manufacture of molding tool and proper selection of materials for your specific use.

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MECHANICAL PRODUCTS DIVISION

HAARTZ-MASON

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Watertown 72, Massachusetts

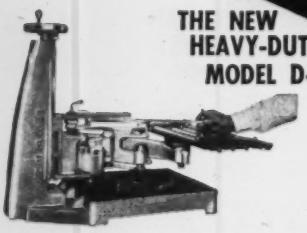
For more information circle **160** on inquiry card.

unique in design — rugged in construction

GREEN PANTOGRAPH ENGRAVERS

THE FAMOUS MODEL 106

THE NEW HEAVY-DUTY MODEL D-2



The three-dimensional bench Model 106 cuts costs — engraves, routs, models and profiles, giving you expert results even by unskilled workers.

The Model D-2 two dimensional heavy-duty Pantograph is a precision machine with a multitude of new features. Open on three sides, it permits complete freedom for engraving, milling, profiling large panels (up to 30" in diameter) or bulky pieces. Single, micrometer adjustment controls vertical depth of cut, automatically adjusting copy table with pantograph. Range of reduction ratios from 2-to-1 to infinity! Vertical range over 10 inches!

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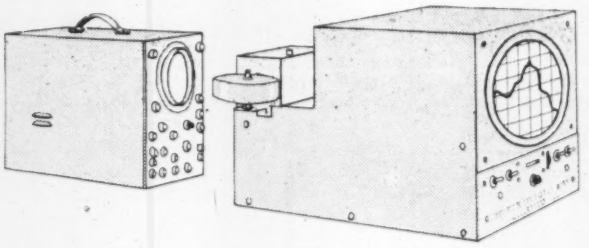


produces 3200 pictures. New frame can be recorded and developed every 2 seconds. (*From new 10-page brochure, Kenyon Instrument Co., 1345 New York Ave., Huntington Sta., L. I., N. Y.*)

For this literature circle **611** on inquiry card.

Punch-card-controlled Machining

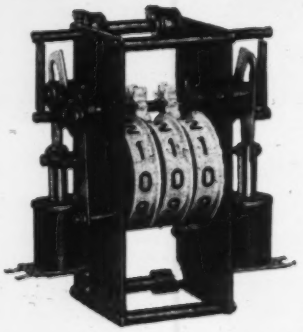
Numerical Positioning Control is a system for automatically controlling machine tools from standard business machine cards. . . . Applications include punch presses, lathes, milling machines, boring machines.

Positioning directions are read from punches in cards. These directions are converted into positioning signals which, through a system of director and pick-up selsyns, direct the machine to the correct machining location.

As the first card is read, the machine positions itself correctly . . . At the same time, machine directions are being read from the card. These machine directions can direct the machining operation to take place before, during, or immediately after the positioning motion.

This card is for part number 003 on drawing 1231678.

NEW . . . A COUNTER that SUBTRACTS as well as COUNTS



SPENCER 2-WAY Magnetic Impulse COUNTER

IDEAL FOR MAINTAINING CAPACITY—

- **On Conveyors**
- **On Machines**
- **On Production and Inventory—and hundreds of other industrial uses.**

Counts and subtracts electrically—opens switch at zero—end of predetermined count.

400 counts per minute—one count up or down per impulse. Actuated by photo electric cell, tube, relay or contact switch.

- **Easy to read**
- **Easy to mount**
- **Well constructed**

See us at Booth 157 Automation Exposition

Outline your problem to us for solution or send for bulletin.

SPENCER MANUFACTURING CO.

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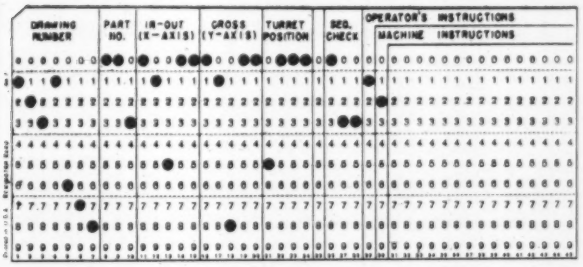
For more information circle **162** on inquiry card.

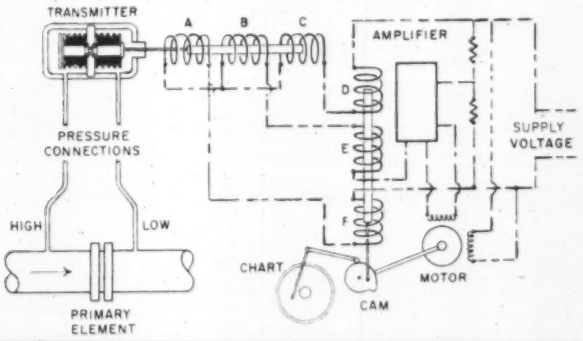


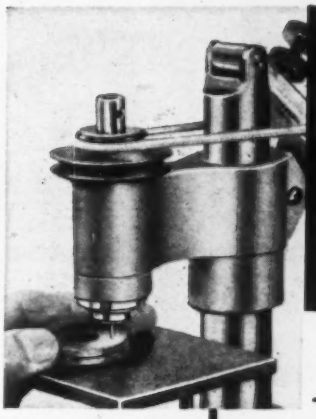
The card will direct the machine to position the X axis at 015.000", the cross feed Y axis at 018.00", and the turret position at 5000. This card number 33. Operator instructions 1 and machine instructions 2 are caller for. (*From new 4-page brochure GEA-6328, General Electric Co., Schenectady 5, N. Y.*)

For more information circle **612** on inquiry card.

Electronic Flowmeter

The transmission system . . . is of the differential transformer, null balance, AC bridge type . . . calibration is un-





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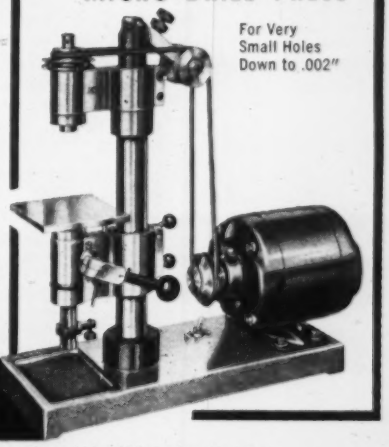
LEVIN

MICRO-DRILL PRESS

Designed to hold small drills in precision collets, thus overcoming the difficulty of making a drill run true as when held in a conventional drill chuck. Absence of a sliding quill guarantees maximum sensitivity with fingertip control. A mounted ⅛" capacity chuck can also be used.

Send for Catalog "M" describing Micro-Drill Press, full range of collet sizes, Micro-Drills, accessories and other precision tools.

For Very Small Holes Down to .002"



LOUIS LEVIN & SON, INC.
3610 S. Broadway
Los Angeles 7, Calif.

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MARSHALLTOWN

DIAPHRAGM GAUGE

For Accurate Pressure Measurement in Ounces or Inches of Water

Available in standard dials (reading in inches of water) 0-15" —0-30" —0-60" —0-100" —0-160" ...also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MANUFACTURING CO.
MARSHALLTOWN 3, IOWA

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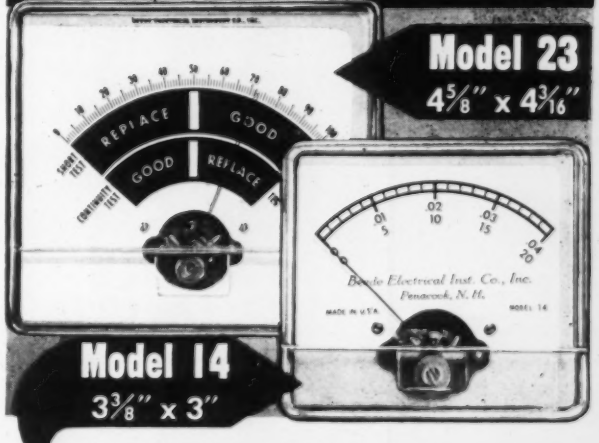
BEEDE ELECTRIC METERS



The NEW Model 14, a companion to Model 23, especially adapted to Test Equipment, Geiger Counters, and Electronic Applications.

Both with Crystal Clear Plastic Cases

Write for Catalog.

BEEDE ELECTRICAL INSTRUMENT CO., INC.
PENACOOK, N. H.

For more information circle **165** on inquiry card.

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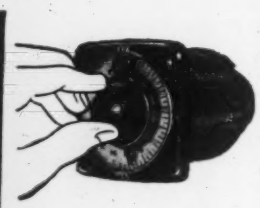
... inventory
... installation
... maintenance

miniature
... for space economy



maximum circuit flexibility
... more than 145 electrical arrangements

An entirely new concept in automatic time interval control, Atcotrol is designed to be the standard in its field.

Requires but one clearance hole for mounting. Atcotrol timer can be demounted from panel in 2 seconds without tools. Completely serviced with a screwdriver. Either reset or stop on power failure. Motor, clutch and reset operation visible from front. Instantaneous reset. No pointer rebound. Built to NEMA standards. Conservatively rated at 10 amps. *Repeat accuracy within .1 of 1%.* Many other new and exclusive features.

Write for complete information.
Trial unit available to o.e.m.'s.
Automatic Temperature Control Company
5224 Pulaski Ave., Philadelphia 44, Pa.
Represented in Canada by: Powerlite Devices, Ltd., Toronto, Montreal and Vancouver.

atc®

ATCOTROL
RESET TIMERS

For more information circle **166** on inquiry card.

NEW **from face to terminal block**

Cramer

type 412 TIME DELAY RELAY

- Exceptional Repeat Accuracy . . . ± ¼ of 1% of full scale.
- New Full-Vision Dial . . .
- Quick-Make, Quick-Break Contacts — rated 15 amps . . .
- New Wiring Flexibility, 9-position terminal block.
- Electrical and mechanical service life tested in excess of one million operations.

Write for full information.

Cramer TIMING DEVICES
17CR55

SPECIALISTS IN TIME CONTROL
The R. W. CRAMER CO., Inc.
BOX 5, CENTERBROOK, CONN.

For more information circle **167** on inquiry card.

affected by line voltage variation or temperature changes between 30 and 125°F. Only three wires are required for the 5-volt metering circuit . . . The amplifier has a voltage gain of approximately 50,000. The motor which positions the core of the receiver differential transformer is the conventional two-phase induction type . . . The cam provides accurate meter calibration.

The transmission system is used between the Hays differential pressure transmitter (for flow measurement) or the Hays-Fisher liquid-level transmitter (for level measurement) and the Hays electronic receiver. (*From new 12-page catalog* 55-1074-222, *The Hays Corp., Michigan City, Ind.*)

For this literature circle **613** on inquiry card.

Sintered Metal Heavier Than Lead

Fansteel 77 Metal is twice as heavy as steel; 50% heavier than lead (specific gravity: 17.0), has high tensile and yield strength; high modulus of rupture; machines like cast iron; fine finishes, close tolerances . . . made by powder metallurgy; no large scrap losses. Pure tungsten is the principal component. A small amount of copper is included to impart good machineability, and the addition of nickel makes it possible to compact and sinter Fansteel 77 Metal parts very close to finish shape and dimensions. (*From new 16-page brochure, Fansteel Metallurgical Corp., North Chicago, Ill.*)

For this literature circle **614** on inquiry card.

Editor, I&A:

Just to show you how alert some of your readers are, we've received several inquiries on the Dewcel material on Page 1138 of your July issue concerning minimum dew point temperatures. Obviously a typographical error, it appears as –150 F., instead of –50 F. (the lower limit at which the Dewcel can be used to measure dew point temperature).

ORIN R. BENSON
The Foxboro Company

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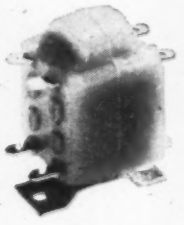
make
Kenyon
your source
of supply
for special
and standard
transformers



MOLDED

Improvements in transformer construction have produced a process for molding an insulated covering which accomplishes hermetic sealing in a finished product amazingly small and light.

- Less volume and weight.
- Exceedingly rugged construction.
- More shock resistant than soldered cases.
- No necessity for hermetically sealed terminals.
- Coating thickness can be varied, according to moisture resistance requirements.
- Considerable savings in cost.

Kenyon
TRANSFORMER CO., INC.
840 Barry Street, New York 59

For more information circle **168** on inquiry card.

Industrial Control Valves

The Cv rating of any valve is the amount of water at standard conditions (60° F, specific gravity=1) in GPM which will pass through the valve with a one psi pressure drop across the valve when in the full open position. This rating is determined by manufacturer's tests and is published in catalogs and specification sheets . . . a valve having a Cv=2 would have twice the flow capacity with the same pressure drop as a valve of Cv=1.

Two charts, one for liquids, the other for compressible fluids, are available from factory. These charts provide a convenient and rapid means for solving fluid flow equations and are similar in nature, utilizing common Cv rating.

The following flow equations are presented:

LIQUID FLOW

$$Q = C_v \sqrt{\frac{\Delta P}{S}}$$

Q=rate of flow, in gallons per minute
C_v=flow rating of the valve
ΔP=pressure drop across the valve (open position), psi
S=specific gravity relative to water at 60° F

GAS

$P_2 \geq$ (1) P critical

$$q_h = 61\ C_v \sqrt{\frac{P_2\ \Delta P}{G}} \times \frac{22.8}{\sqrt{T}}$$

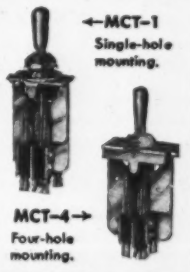
$P_2 \leq$ (2) P critical

$$q_h = 61\ C_v \frac{P_1}{2\sqrt{G}} \times \frac{22.8}{\sqrt{T}}$$

q_h=rate of flow CFH, at 14.7 psia and 60° F (standard conditions)
C_v=flow rating of the valve
P_1=upstream pressure, psia
P_2=downstream pressure, psia
P critical=53% P_1
ΔP=pressure drop across the valve (open position), psi
G=specific gravity of gas, relative to air at 14.7 psi and 60° F (standard conditions)
T=absolute temperature in degrees Fahrenheit (460+° F)

(From new 48-page Industrial Catalog, 1955 Edition, General Controls Co., 801 Allen Ave., Glendale 1, Calif.)

For this literature circle **615** on inquiry card.

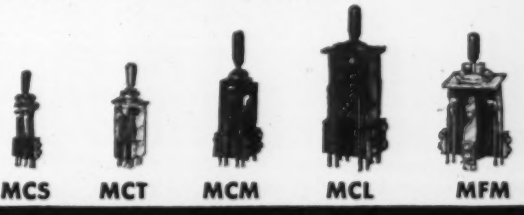


Type MCT Lever Switch

Solid switch frame provides electro-static shield. Variety of lever operations and contact assemblies provide multiple circuit control. Fine silver or palladium silver contacts available.

Write for Bulletin CL-100

All General Control switches feature riveted coin silver or palladium alloy contacts and are individually adjusted and inspected. Switch types are available from 1 to 10 amperes.
Also available are special switches and contact assemblies to customer specifications.

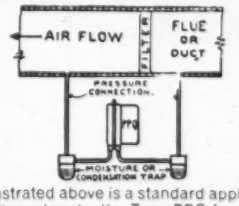


FOOT, LEVER, PUSH BUTTON and LIMIT SWITCHES
ELECTRONIC and SYNCHRONOUS-MOTOR TIMERS
CUSTOM CONTROL PANELS

GENERAL CONTROL COMPANY
1218 Soldiers Field Road • • Boston 34, Massachusetts

For more information circle **170** on inquiry card.

CONTROL FROM MINUTE CHANGES IN THE RELATIONSHIP OF TWO PRESSURES



Illustrated above is a standard application whereby the Type PPQ functions to open (or close) an electrical circuit from a variation in pressure differential due to a clogging filter.

Mercoid Type PPQ Diaphragm Differential Pressure Controls operate from minute changes (.03" water) in the difference between two pressures.

Ranges to cover most applications (inches of water) 6" vacuum to 6" pressure, and 30" vacuum to 30" pressure. Available for various circuit arrangements.

Electrical Capacity—0.3Amp. at 115V., A.C. or 0.15 Amp., at 230V., D.C. Can be furnished in explosion-proof or weather-proof cases.

WRITE FOR BULLETIN CA-3P

THE MERCOID CORPORATION
4205 W. BELMONT AVENUE, CHICAGO 41, ILLINOIS
New York: 205 East 42nd St. Philadelphia: 3137 N. Broad St.

For more information circle **169** on inquiry card.

GULMITE TOOLS

Send for our free brochure on Gulmite Tools —a serrated tool for every purpose.

Also listed are various sizes that fit the different makes of drives, wrenches and drive adapters. A partial list of manufacturers who use Gulmite Tools contains names of well known firms that invite confidence.

BERGANDER MFG. CO.
2129 WARNER AVENUE CHICAGO 18, ILLINOIS

For more information circle **171** on inquiry card.

New Literature...

INSTRUMENTS and AUTOMATION

For literature use the postage-free order card on page 1781

AUTOMATION

Process Recorder-Controller. New 12-page illustrated Brochure E12-4 describes maker's new d-c potentiometric receiver recorder and controller for temperature, pH force, pressure, etc. —Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **616** on inquiry card.

Systems Engineering. New 12-page Brochure C901 discusses typical industrial control systems involving data reduction, transmission systems, jet engine tachometer controllers, wind tunnel computer controller and process connectors.—Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif.

Circle **617** on inquiry card.

Process Control. New 4-page issue of "Wheelco Comments" (No. 4, Vol. 15) describes use of "Heil" dehydrators with maker's controls in processing of grains.—Wheelco Instruments, Barber-Colman Co., Rockford, Ill.

Circle **618** on inquiry card.

Annunciators. New 2-page bulletin describes maker's "Model SC-10 Du-All" annunciators used to provide self-contained alarm systems for use with modern control systems. — Scam Instrument Corp., Chicago 18, Ill.

Circle **619** on inquiry card.

Combustion Control. New 4-page Bulletin E-104 describes maker's automatic combustion control for oil, gas or coal fired boilers.—Reliance Instrument Mfg. Corp., 190 Glen Cove Ave., Glen Cove, L. I., N. Y.

Circle **620** on inquiry card.

VALVES

Control Valves. New 8-page brochure describes maker's "Type CV" control valve with "Isoforce" actuator. —Foster Engineering Co., 835 Lehigh Ave., Union, N. J.

Circle **621** on inquiry card.

Solenoid Valve. New 2-page Bulletin V5003 describes maker's four-way dual- and single-solenoid valves.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle **622** on inquiry card.

Control Valves. New 4-page Bulletin 966 describes maker's "Type 10" pilot-operated control valve for pressure reduction and back-pressure control. —A. W. Cash Co., P. O. Box 551, Decatur, Ill.

Circle **623** on inquiry card.

Valves. New 2-page bulletin pictures and describes maker's No. 23 drain or sampling valve.—Jerguson Gage & Valve Co., Somerville, Mass.

Circle **624** on inquiry card.

Valves. New 24-page Catalog 207 describes and illustrates maker's pressure regulating and relief valves.—Schade Valve Mfg. Co., 2527-2537 N. Bodine St., Philadelphia 33, Pa.

Circle **625** on inquiry card.

Valves. New 6-page Bulletin 551 describes maker's forged-steel valves for steam-power stations, boiler piping, etc.—Edward Valves, Inc., 1201 W. 145th St., E. Chicago, Ind.

Circle **626** on inquiry card.

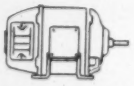
Valves for Corrosive Service. New 4-page bulletin describes maker's "Causul" (CAUStic soda and SULfuric acid) metal gate valves used for handling corrosive fluids in oil refineries. —Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

Circle **627** on inquiry card.

Valves. New 4-page Catalog 300 describes maker's "Style JB Protecto-Seal" bellows relief valve.—Crosby Steam Gage & Valve Co., Wrentham, Mass.

Circle **628** on inquiry card.

MOTORS



Air Motors. New 8-page Bulletin ML-3 contains illustrations and descriptions of maker's air cylinders and applications on drill press feeds, index tables, etc.—Bellows Co., 222 W. Market St., Akron, Ohio.

Circle **629** on inquiry card.

Motors. New 2-page Catalog Sheet 3755 describes maker's permanent-magnet miniature motor.—Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.

Circle **630** on inquiry card.

TEMPERATURE

Pyrometer Controllers. New 12-page Bulletin F7259 presents service tips for pyrometer users.—Barber-Colman Co., Wheelco Instruments Div., Rockford, Ill.

Circle **631** on inquiry card.

TC Connectors. New 2-page Specification Sheet 56 describes maker's "AN" thermocouple connectors used in test installations requiring fast set-up.—Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle **632** on inquiry card.

Temperature Controller. New 2-page Bulletin F-5795-2 describes maker's "Capaciline" supplementary control device which "anticipates" fuel needs of controlled heating equipment. —Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle **633** on inquiry card.

Thermostat. New 2-page Bulletin 120 describes and illustrates maker's "Model A-1S-160" thermostat for lab baths and ovens.—Burling Instrument Co., 16 River Rd., Chatham, N. J.

Circle **634** on inquiry card.

Electronic Clinical Thermometer. New 2-page bulletin describes maker's new "Rapid-Temp" electronic indicating clinical thermometer.—Standard Scientific Supply Corp., 34 West 4th St., New York 12, N. Y.

Circle **635** on inquiry card.

Dial Thermometers. New 4-page leaflet describes maker's dial thermometers used for industrial and laboratory applications.—Marshall Instruments, Inc., 6859-61 Tujunga Ave., N. Hollywood, Calif.

Circle **636** on inquiry card.

Temperature Control. New 2-page bulletin 1-T describes precise temperature control system for high-pressure tube reactors.—Pressure Products Industries, Inc., Hatboro, Pa.

Circle **637** on inquiry card.

Temperature Measurement. New 8-page leaflet describes and illustrates various methods of measuring temperature, history and concepts of measuring temperature, etc.—Tempil Corp., 132 W. 22nd St., New York 11, N. Y.

Circle **638** on inquiry card.

Cartridge Heaters. New 4-page Bulletin 850 describes and illustrates maker's complete line of electric cartridge units.—Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.

Circle **639** on inquiry card.

Furnace Elements. New 10-page booklet presents applications of maker's tube elements for high-temperature furnaces.—Kanthal Corp., 7 Amelia Place, Stamford, Conn.

Circle **640** on inquiry card.

Electric Furnaces. New 24-page Catalog D-5 presents description, specifications, dimensions, etc. of maker's electric furnaces.—Cooley Electric Mfg. Corp., 38 S. Shelby St., Indianapolis 7, Ind.

Circle **641** on inquiry card.

PRESSURE

Pressure Transducer. New 4-page bulletin describes maker's "Model S-6B" pressure transducer with voltage output.—Ultradyne Engineering Labs, Inc., P. O. Box 8007, Albuquerque, N. Mex.

Circle **642** on inquiry card.

Pressure Transducer. New 4-page brochure describes maker's "Model S-6A" pressure transducer for FM/FM inductance controlled telemetering systems, etc.—Ultradyne Engineering Labs., Inc., P. O. Box 8007, Albuquerque, N. Mex.

Circle **643** on inquiry card.

Pressure Transducers. New 12-page Bulletin MPT-1 describes maker's miniature pressure transducers for measuring differential, absolute and gage pressures.—Statham Labs., Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle **644** on inquiry card.

Differential-Transformer Systems. New 6-page folder pictures and describes maker's LVDT (low-voltage diff-transf) transducers and controllers for displacement, pressure, etc.—Daytronic Corp., 216 S. Main St., Dayton 2, Ohio.

Circle **645** on inquiry card.

Surge Control. New 36-page Catalog 52 presents specifications of maker's "Magnilastic" expansion joints and "Hydropads" for pipeline surge control.—Cook Electric Co., 2700 N. Southport Ave., Chicago, Ill.

Circle **646** on inquiry card.

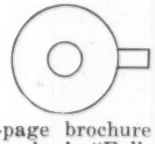
Pressure Gage Snubber. New 2-page Bulletin 1191A11 describes and illustrates maker's "Model 6011" pressure gage snubber used to prevent damage to gage from pressure surges.—Parker Appliance Co., Tube & Hose Fittings Div., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **647** on inquiry card.

Pressure. New 4-page brochure describes and illustrates maker's Dynagage "Model DG-400" electronic instrument for measuring static and dynamic pressures.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena 8, Calif.

Circle **648** on inquiry card.

FLOW



Rotameter. New 20-page brochure pictures and describes maker's "Full-View" rotameter used for flow measurement and control.—Brooks Rotameter Co., Lansdale, Pa.

Circle **649** on inquiry card.

Flow Tube. New 6-page Bulletin FT describes maker's "Gentile" flow tube for metering water, air, steam, oil, jet fuel, etc.—Foster Engineering Co., 835 Lehigh Ave., Union, N. J.

Circle **650** on inquiry card.

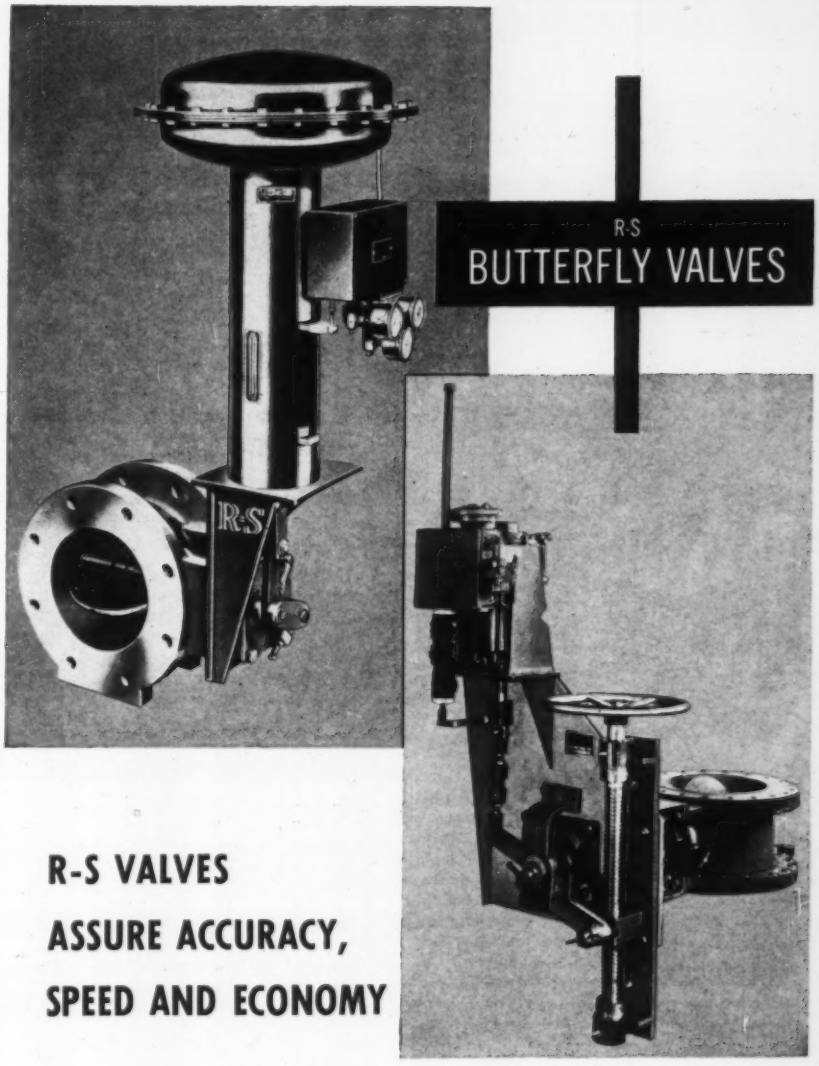
Wind Instruments. New 12-page Bulletin 6000 presents specifications on maker's anemometers, wind recorders, pilot balloon theodolites, etc. —W. & L. E. Gurley, Troy, N. Y.

Circle **651** on inquiry card.

Purge Meter. New 2-page Bulletin 135 describes maker's "Sho-Rate 50" purge meter for metering small flows. —Brooks Rotameter Co., Lansdale, Pa.

Circle **652** on inquiry card.

Flow and Pressure Control. New 6-page Bulletin 285-M30 describes



R-S VALVES ASSURE ACCURACY, SPEED AND ECONOMY

With automatic controls – R-S Valves will give the most positive and dependable performance obtainable . . .

UNIFORM CONTROL IN ALL POSITIONS . . .
R-S Valves give consistent flow control through all positions in the normal regulating range. The disc simulates a straight line, semi-log characteristic. Cam-driven positioners can furnish other characteristics as required.

REGULATION AND CLOSURE ARE QUICK . . .
Power actuation provides fast or slow regulation-time.

MINIMAL PRESSURE DROP SAVES POWER . . .
In open position the streamlined disc effects less pressure drop than many types of valves. This will show considerable reduction in pumping costs.

S. Morgan Smith offers the best in valve engineering for your control applications. To find the proper valve for any application, or to get additional information on our complete line of butterfly, ball and cone valves, write to the S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines · Pumps · Gates & Hoists · Trash Rakes · Accessories

HYDRODYNAMICS

Rotovalves · Ball Valves · Butterfly Valves · Free-Discharge Valves · Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

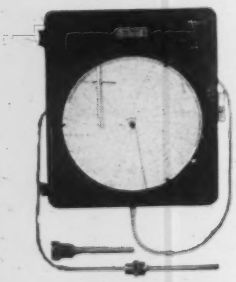
AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

For more information circle **172** on inquiry card.

4½" DIAL THERMOMETERS

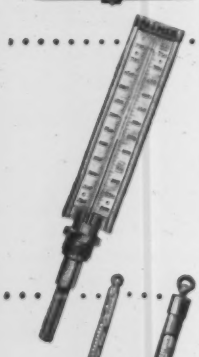
Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

PALMER
MERCURY ACTUATED
Temperature Indicating Instruments



RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.



INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

Write For Catalog Information

PALMER
THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

For more information circle **173** on inquiry card.

NEW LITERATURE

maker's flow and pressure control in water filtration and waste treatment plants.—Builders-Providence, Inc., 345 Harris Ave., Providence, R. I.

Circle **653** on inquiry card.

Metering and Feeding. New 2-page Application Memo K13 describes removal of precipitated colloidal impurities automatically in refining of raw sugar beet juice by proportional feeding and metering.—B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.

Circle **654** on inquiry card.

Air Meters. New 4-page Bulletin A-8 describes maker's "Tool-om-eter and Drill-om-eter" compressed-air meters that indicate flow rate of air to pneumatic tools, equipment, etc. —New Jersey Meter Co., Plainfield, N. J.

Circle **655** on inquiry card.

Pumps. New 16-page Bulletin S-1254 illustrates and describes maker's controlled capacity pumps and liquid proportioning equipment.—Philadelphia Pump & Machinery Co., Inc., Phila., Pa.

Circle **656** on inquiry card.

RECORDING, DATA PROCESSING

Data Processing. New 16-page issue of "CEC Recordings" (Vol. 9, No. 4) features article on "DataTape to Speed Aviation Testing."—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Circle **657** on inquiry card.

Digital Data Recorder. New 14-page catalog describes maker's "RBI" (Resistance Bridge Indicator) systems for digital data recording with the "200 series" resistance bridge indicator.—American Helicopter Div., Fairchild Engine & Airplane Corp., 1800 Rosecrans, Manhattan Beach, Calif.

Circle **658** on inquiry card.

X-Y Plotters. New 6-page folder describes and illustrates maker's X-Y plotters and recorders for binary, binary coded decimal or decimal inputs.—Librascope, Inc., 808 Western Ave., Glendale, Calif.

Circle **659** on inquiry card.

Data Repeaters. New 6-page Brochure A-2372 describes maker's a-c data repeaters used to repeat data to aircraft navigator and pilot, for recording temperature, fuel quantity, etc.—AC Spark Plug Div., Electronics Div. of General Motors Corp., 1925 E. Kenilworth Place, Milwaukee 2, Wisc.

Circle **660** on inquiry card.

Oscillographs. New 16-page leaflet describes maker's "Type MRC-21" strain gage control unit, "Type S20" aircraft oscillograph, "Type RS-20" portable strain indicator, etc.—Hathaway Instrument Co., 1315 S. Clarkson St., Denver 10, Colo.

Circle **661** on inquiry card.

Digital Recording Systems. New 8-page booklet describes maker's digital recording systems which collects data relative to temperature, pressure, weight, speed, etc.—Metrotype Corp., Michigan City, Ind.

Circle **662** on inquiry card.

Data Reduction. New 2-page illustrated booklet describes maker's "Vanguard" motion analyzer that permits data reduction from photographed information.—Vanguard Instrument Corp., 184 Casper St., Valley Stream, N. Y.

Circle **663** on inquiry card.

Potentiometer. New 2 page bulletin describes maker's "Model 2705" recording potentiometer.—Westronics, Inc., 3605 McCart St., Fort Worth, Tex.

Circle **664** on inquiry card.

Curve Tracer. New 8-page booklet describes maker's "Type 570" characteristic-curve tracer which plots vacuum tube characteristics over a wide range of operating conditions. —Tektronix, Inc., P. O. Box 831, Portland 7, Oregon.

Circle **665** on inquiry card.

Ballistocardiograph. New set of bulletins describes maker's "Arbeit d-v-a" ballistocardiograph for recording all functions of motion imparted by cardiac systole.—Industrial Development Labs., Inc., 17 Pollock Ave., Jersey City 5, N. J.

Circle **666** on inquiry card.

TIME, COUNT

Time Measuring System. New 2-page bulletin describes maker's "Model B-4" time measuring system for measuring delay time of delay lines, pulse-forming networks, etc.— Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.

Circle **667** on inquiry card.

Timer. New 2-page bulletin presents electrical and mechanical applications of maker's "M.G." timer.—Gorrell & Gorrell, Haworth, N. J.

Circle **668** on inquiry card.

Time Recorder. New 4-page brochure describes maker's time recorder and totalizer for computing and registering total operations time, etc.— Standard Instrument Corp., 657 Broadway, New York 12, N. Y.

Circle **669** on inquiry card.

Time Indicators. New 2-page Bulletin 5 describes maker's hermetically-sealed elapsed-time indicators with 1.5-in. diam.—Haydon Mfg. Co., Inc., Torrington, Conn.

Circle **670** on inquiry card.

Counter Assembly. New 2-page Bulletin B-462 presents specifications of maker's "Model 4-H-8455" counter assembly for 50,000 pm.—Durant Mfg. Co., Milwaukee, Wis.

Circle **671** on inquiry card.

Periodic-Reverse Units. New 2-page bulletin pictures and describes maker's "Model 500" periodic-reverse units for copper and silver plating.—Unit Process Assemblies, Inc., 75 E. 4th St., New York 3, N. Y.

Circle **672** on inquiry card.

COMPUTERS

Card Detector. New 4-page illustrated folder presents details on

DAGE "AN EXTENSION OF HUMAN VISION"

RAILROAD'S USE OF CLOSED-CIRCUIT TV BY DAGE SPEEDS FREIGHT-CAR HANDLING

DAGE TV is in daily use at the Potomac Yard at Alexandria, Va., which serves *five* large railroads. As incoming trains move across viewing screens at a central control station, the operator completely identifies each car, quickly and safely, regardless of weather. Sorting and regrouping of trains are expedited and costly errors are avoided.

IN BUSINESS, INDUSTRY AND EDUCATION, closed-circuit DAGE TV is proving itself every day in scores of ways. Business records are inspected and signatures verified . . . dangerous operations are viewed safely . . . inaccessible devices are easily supervised . . . training groups view special processes and operations at distant locations . . . careful security watches are kept on key points.

INEXPENSIVE TO INSTALL AND OPERATE, DAGE TV is a visual tool that pays for itself many times over. *Whatever your business* . . . find out how closed-circuit TV by DAGE can improve your operations and lower costs in many ways. For a free booklet detailing DAGE equipment and installations, write, wire or phone Dept. IA-1, DAGE TELEVISION, Michigan City, Indiana . . . Michigan City 3-3251.

DAGE TELEVISION
Division of Thompson Products, Inc.
Michigan City, Indiana

IN CANADA DISTRIBUTED BY ROGERS MAJESTIC ELECTRONICS, LIMITED, TORONTO, ONTARIO.

For more information circle **174** on inquiry card.

maker's duplicate card detector which segregates multiple-item groups of punched cards for separate summarization.—Remington Rand Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.

Circle **673** on inquiry card.

Computer Components. New 12-page Brochure TDS-2300 describes maker's "Servomation" electromechanical general-purpose analog-computer components. Includes demodulator, servo amplifier, Servoscope, Servoboard, etc.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Circle **674** on inquiry card.

DIGITAL CONVERTERS

Digital Converter. New 6-page folder describes maker's analog-digital converter which transfers data from shaft to code discs.—Librascope, Inc., 808 Western Ave., Glendale, Calif.

Circle **675** on inquiry card.

Digital Converter. New 8-page illustrated brochure describes maker's analog-to-digital converter and systems.—J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif.

Circle **676** on inquiry card.

TESTING, INSPECTION

Hardness Tester. New 6-page Bulletin 5501 pictures and describes maker's "Model 164 Dyhedron" dynamic diamond tester for measuring hardness and lubricity of materials.—Taber Instrument Corp., 111 Goundry St., N. Tonawanda, N. Y.

Circle **677** on inquiry card.

Humidity Chamber. New 4-page Bulletin 5525 illustrates maker's annular mechanical convection-controlled relative-humidity chamber.—Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.

Circle **678** on inquiry card.

Surface Profiles. New 4-page Form B2 presents line of instruments for measuring surface characteristics and displacements.—Micrometrical Development Corp., 2821 S. State St., Ann Arbor, Mich.

Circle **679** on inquiry card.

High-Current Test Instruments. New 4-page Data Sheet 4755 presents maker's line of portable high-current "Multi-Amp" test instruments.—Multi-Amp Corp., 10 Third St., Newark, N. J.

Circle **680** on inquiry card.

Thickness Tester. New 2-page descriptive bulletin illustrates maker's "Dermitron" non-destructive thickness tester.—Unit Process Assemblies, Inc., 75 E. 4th St., New York 3, N. Y.

Circle **681** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Plug-in Units. New 40-page illustrated Catalog 827 presents circuits and specifications on maker's 36 plug-in basic circuits used for design and production of electronic equipment.—EECO Production Co., 506 E. First St., Santa Ana, Calif.

Circle **682** on inquiry card.

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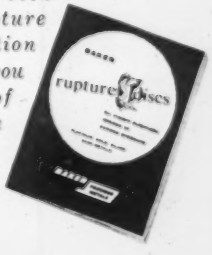

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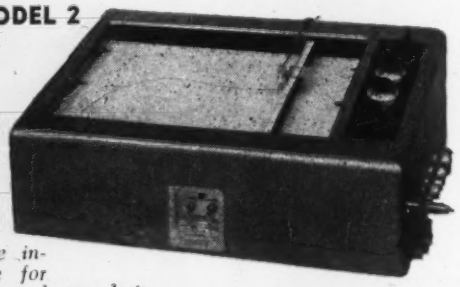

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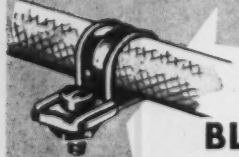

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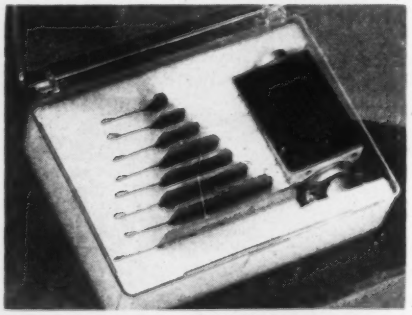

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For more information circle **178** on inquiry card.

NEW LITERATURE

Transistor Circuits. New 8-page booklet describes typical "Type 2N107" transistor circuits.—General Electric Co., Schenectady 5, N. Y.

Circle **683** on inquiry card.

Proximity Meter. New 28-page Technical and Application Manual TM-951-1 describes maker's proximity-meter capacitance-gage for measuring minute variations in capacitance.—Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Phila. 33, Pa.

Circle **684** on inquiry card.

Oscillograph. New 16-page issue of "Oscillographer" (Vol. 15, No. 3) describes maker's cathode-ray oscillograph display system used with high-speed electronic computers.—Allen B. DuMont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **685** on ilnquiry card.

Oscilloscope. New 4-page brochure describes maker's "Model 411 Easy-Six" oscilloscope for precision testing. —Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass.

Circle **686** on inquiry card.

Servoscope. New 4-page folder presents industrial applications and specifications of maker's "Servoscope" for measuring gain and phase shifts in servosystems.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Circle **687** on inquiry card.

Servo Amplifiers. New 8-page folder describes maker's "Models B-1, B-2, and B-3" magnetic servo amplifiers used in servo systems.—Feedback Controls, Inc., 1332 N. Henry St., Alexandria, Va.

Circle **688** on inquiry card.

Capacitor Leakage Tester. New 2-page bulletin describes maker's "Model 393" capacitor leakage tester for detecting leakage in paper, mica, or ceramic capacitors.—Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.

Circle **689** on inquiry card.

Digital Voltmeter. New set of bulletins (100, 240 & 241) describe and illustrate maker's "Models 450 & 451" digital voltmeters for measuring, displaying and recording analog computer outputs automatically in digital form.—Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.

Circle **690** on inquiry card.

Frequency Measurement. New 6-page issue of "Hewlett-Packard Journal" (Vol. 6, No. 12) features article on "A Simple Precision System for Measuring CW and Pulsed Frequencies Up to 12,400 MC."—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle **691** on inquiry card.

Voltage Divider. New 8-page issue of 'Experimenter" (Vol. 30, No. 3) describes maker's voltage divider for d-c and audio frequencies.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **692** on inquiry card.

Electronic Instruments. New set bulletins describe maker's incidental-frequency modulation meter, stop attenuator, multi-purpose signal gen-

erator, "Vibrotron" digital pressure gages, etc.—Byron Jackson Co., 492 E. Union St., Pasadena, Calif.
Circle **693** on inquiry card.

Electrical Test Instruments. New 4-page booklet describes and illustrates maker's impedance bridge, a-c and d-c generator-detector, "Dekavider" potentiometer for rack mounting, etc.—Electro Measurements, Inc., 4213 S.E. Stark St., Portland 15, Oregon.
Circle **694** on inquiry card.

Laboratory Electrical Instruments. New 4-page bulletin describes maker's laboratory instruments for a-c and d-c measurements.—Physics Research Labs., Inc., 507 Hempstead Turnpike, W. Hempstead, N. Y.
Circle **695** on inquiry card.

Amplifier. New 2-page bulletin presents specifications of maker's "CA-401" current amplifier for converting small voltage changes from high impedance source into large current changes for low impedance loads.—Photocon Research Products, 421 N. Foothill Blvd., Pasadena, Calif.
Circle **696** on inquiry card.

Power Circuit Analyzer. New 4-page folder presents specifications of maker's power circuit analyzer for measuring current, voltage, power factor and line frequency.—Physics Research Labs., Inc., 507 Hempstead Turnpike, W. Hempstead, N. Y.
Circle **697** on inquiry card.

Electronic Equipment. New 24-page booklet describes corporation's facilities and personnel for production of precision electromechanical, electronic and electric equipment.—Telectro Industries Corp., 35-16 37th St., Long Island City 1, N. Y.
Circle **698** on inquiry card.

Oscilloscope. New 4-page bulletin presents specifications on maker's "Model K-26" dual-channel oscilloscope.—Electronic Tube Corp., 1200 E. Mermaid Lane, Phila. 18, Pa.
Circle **699** on inquiry card.

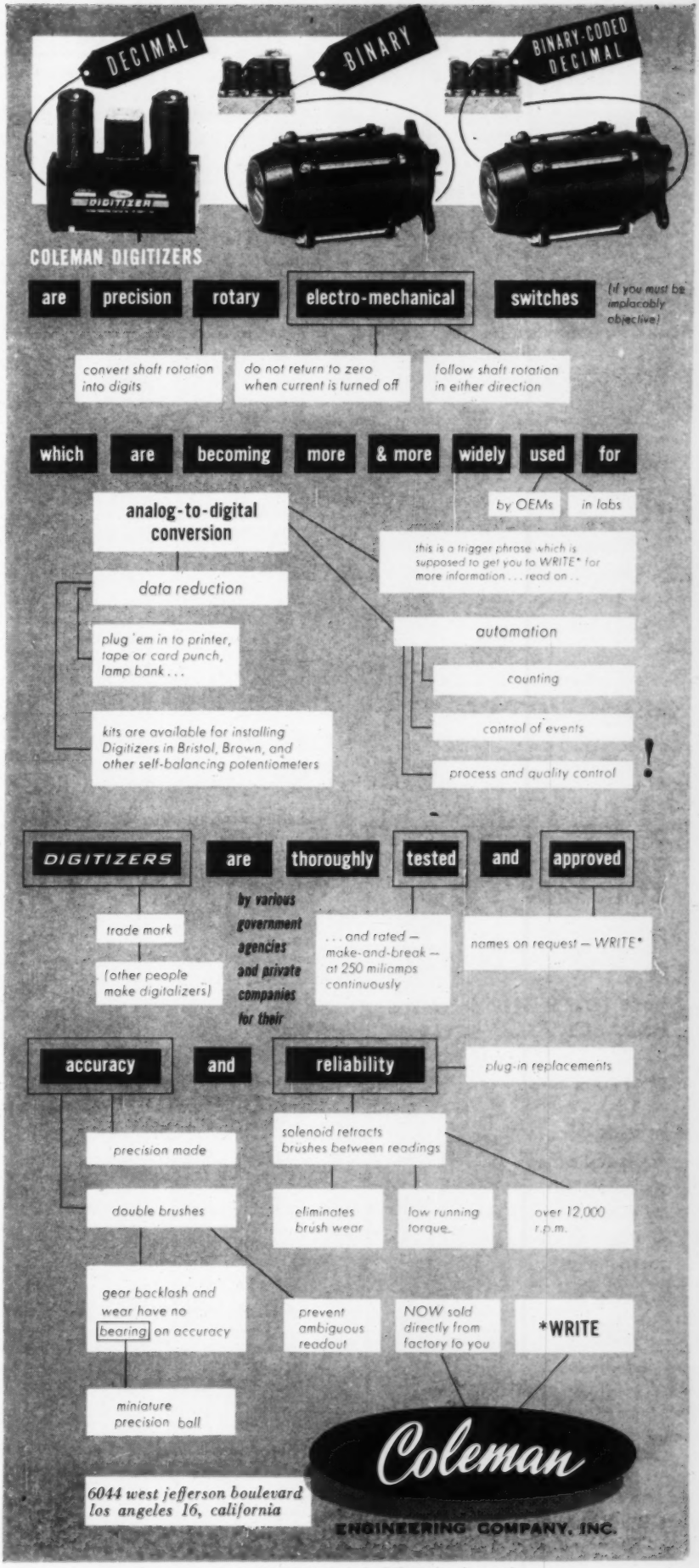
Servo Amplifier. New 2-page illustrated bulletin describes maker's "Type T1616JC" magnetic servo amplifier used in servo systems employing two-phase 400-cycle induction motors.—Specialties, Inc., Skunks Misery Rd., Syosset, L. I., N. Y.
Circle **700** on inquiry card.

Oscilloscope. New 2-page bulletin describes maker's "Model 315" 5" oscilloscope for general applications.—Precise Development Corp., Oceanside, N. Y.
Circle **701** on inquiry card.

Printed Circuit Layouts. New 2-page Bulletin 163 describes maker's self-sticking pre-cut terminal circles and connector strips for printed circuit master layouts.—W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 12, Wisc.
Circle **702** on inquiry card.

Carrier-type Amplifier. New 4-page bulletin presents specifications of maker's "Model EKA-1D" control system using 3-kc-carrier amplifier for use with inductive or reluctance pickups.—Crescent Engineering and Research Co., 11632 McBean St., El Monte, Calif.
Circle **703** on inquiry card.

Power Amplifier. New 4-page bulletin describes maker's "Model PFB-150WD" power amplifier.—Gotham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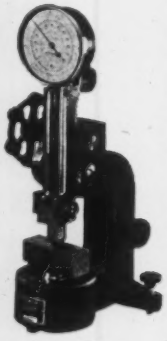

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For more information circle **181** on inquiry card.

NEW LITERATURE

Audio Development Corp., 2 West 46 St., New York 36, N. Y.

Circle **704** on inquiry card.

RADIOACTIVITY

Nuclear Reactor Control. New 8-page brochure lists maker's nuclear reactor controls including: amplifiers, power supplies, detectors and recorders.—Industrial Div., Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **705** on inquiry card.

Reactor Simulator. New 4-page Folder ND46-70-700 describes maker's nuclear reactor simulator.—Leeds & Northrup Co., 444 N. 16th St., Phila. 30, Pa.

Circle **706** on inquiry card.

Radiography. New 8-page issue of "Radiation Digest" (Vol. 2, No. 3) presents article on the "Effect of Focal Spot on Radiography."—X-Ray Dept., General Electric Co., 4855 Electric Ave., Milwaukee 1, Wisc.

Circle **707** on inquiry card.

Exploration Counter. New 4-page Bulletin 130 presents specifications on maker's "Model SC130GP" exploration counter for carborne survey, hole probing, etc.—Mount Sopris Instrument Corp., 1320 Pearl St., Boulder, Colo.

Circle **708** on inquiry card.

Radioisotopes. New 4-page Bulletin 367 presents list of maker's accelerator-produced radioisotopes.—Nuclear Science and Engineering Corp., P. O. Box 10901, Pgh. 36, Pa.

Circle **709** on inquiry card.

Pulse-height Analyzers. New Data Sheets RIDL 114-5 list features of all existing single-channel pulse-height analyzers.—Radiation Instrument Development Lab., 2337 W. 67th St., Chicago 36, Ill.

Circle **710** on inquiry card.

OPTICAL

Infrared Optical Systems. New 4-page leaflet describes maker's electronic optical systems used for detection and reception of invisible light in infrared range of spectrum.—Meyer-Opticraft, Inc., 39 West 60 St., N. Y. C. 23, N. Y.

Circle **711** on inquiry card.

Spectrophotometer. New 2-page bulletin describes maker's "Spectral-polarid" spectrophotometer for measuring transmissibility of light through substances.—Curtiss-Wright Corp., Caldwell, N. J.

Circle **712** on inquiry card.

Photomicrography. New 6-page Data Sheet 2-9 pictures and describes maker's "Model U" universal photomicrographic camera.—Brinkmann Instruments, Inc., 378-380 Great Neck Rd., Great Neck, L. I., N. Y.

Circle **713** on inquiry card.

Photography. New 60-page booklet "How to Organize and Operate Photographic Service Departments" discusses purposes and applications of service photography, etc. Price 50c.—Eastman Kodak Co., Rochester 4, N. Y.

Circle **714** on inquiry card.

Photography. New 52-page Booklet S-8 "Photographic Production of Slides and Film Strips" discusses photographing flat copy, making black and white positives, etc. Price 50c.—Eastman Kodak Co., Rochester 4, N. Y.

Circle **715** on inquiry card.

MAGNETICS

Magnets. New 4-page Bulletin 15 lists types of "Indox I" ceramic permanent magnets available for experimental purposes.—Indiana Steel Products Co., Valparaiso, Ind.

Circle **716** on inquiry card.

Magnetic Test Limits. New 4-page Technical Bulletin DMF-1 presents article "Magnetic Test Limits for Standard El Laminations."—Thomas & Skinner Steel Products Co., Inc., 1120 E. 23rd St., Indianapolis, Ind.

Circle **717** on inquiry card.

MOTION

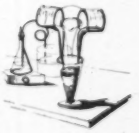
Acceleration Pickups. New 4-page product description sheet describes maker's acceleration pickups (linear voltage-divider pickoff and switching-type).—Cedar Engineering, Inc., Minneapolis, Minn.

Circle **718** on inquiry card.

Vibration Control. New 2-page Bulletin 500-4 describes maker's "Model 4" electronic "Vibraswitch" which automatically cuts-out in the event of excessive vibration protecting heavy equipment against damage.—Beta Corp., Forest Ave. at Ridge Rd., Box 8625, Richmond 26, Va.

Circle **719** on inquiry card.

ANALYTICAL, LABORATORY



Analytical Instruments. New 6-page folder presents a bibliography and index of descriptive literature and reprints that cover maker's line of analytical instruments.—Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.

Circle **720** on inquiry card.

pH Control. New 4-page Data Sheet 700(2) describes and illustrates methods for controlling pH and redox in industrial waste treatment processes.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **721** on inquiry card.

pH Equipment. New 16-page Bulletin Q1305 presents features of maker's pH recorders and controllers, strip-chart recorders for pressure, liquid level, temperature, etc.—Bristol Co., Waterbury 20, Conn.

Circle **722** on inquiry card.

pH Equipment. New 4-page Specification Sheet 425 is "Buyers Guide" for pH equipment, including a chart for selecting correct replacement or additional equipment for pH installations. —Beckman Div., Beckman Instruments, Inc., Fullerton, Calif.

Circle **723** on inquiry card.

Recording Spectrophotometer. New 4-page Bulletin CH-310 describes maker's "H 800" recording infrared spectrophotometer.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **724** on inquiry card.

Spectrometer. New 6-page brochure describes maker's "Tri-Carb" liquid scintillation spectrometer for counting tritium and carbon samples.—Packard Instrument Co., P. O. Box 428, Lagrange, Ill.

Circle **725** on inquiry card.

Spectrograph. New 4-page Bulletin 52 presents specifications on maker's 3-meter concave-grating spectrograph. —Baird Associates, Inc., 33 University Rd., Cambridge, Mass.

Circle **726** on inquiry card.

Lab Apparatus. New 20-page issue of "Burrell Announcer" (No. 55, 9, 59) describes maker's three-speed stirrer, micromet etcher, mercury dispenser, etc.—Burrell Corp., 2223 Fifth Ave., Pgh. 19, Pa.

Circle **727** on inquiry card.

Laboratory Heater. New 2-page Bulletin 626 presents applications and features of maker's "Ful-Kontrol" heater.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **728** on inquiry card.

Dual Titrometer. New 4-page Bulletin 615 pictures and describes maker's "Precision-Shell" dual titrometer that permits two different titrations to be run at same time.—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Circle **729** on inquiry card.

POWER SUPPLIES

Voltage Controller. New 2-page Bulletin 3.14 describes maker's Regohm finger-type VF control for inverters and motor-alternator sets.—Electric Regulator Corp., Norwalk, Conn.

Circle **730** on inquiry card.

Power Supply. New 4-page folder pictures and describes maker's "N-401" high-voltage (500 to 1800 v d-c) power supply.—Hamner Electronics Co., Inc., P. O. Box 531, Princeton, N. J.

Circle **731** on inquiry card.

Power Supplies. New 2-page bulletin describes maker's "R-10" superregulated (better than 0.07% regulation) power supply for 200-325 v dc. —Laboratory of Electronic Engineering, Inc., 413 L Street N. W., Washington, D. C.

Circle **732** on inquiry card.

Power Supply. New 4-page Supplement 1A describes maker's 1.5-amp regulated d-c power supply.—Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y.

Circle **733** on inquiry card.

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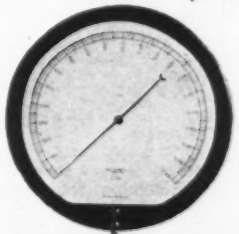

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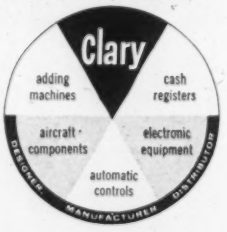

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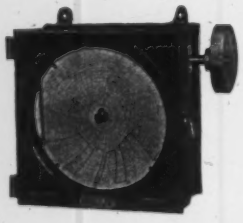

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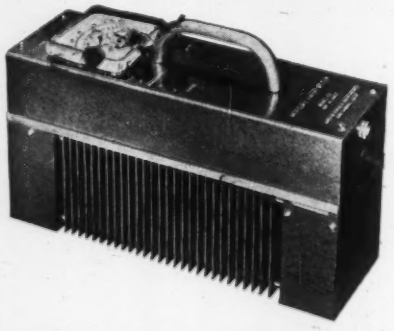

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For more information circle **185** on inquiry card.

NEW LITERATURE

RESISTORS, POTENTIOMETERS

Resistors. New 8-page Bulletin G-la presents data on construction, specifications, terminations, etc., on maker's "Type MV" high-voltage resistors.—International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle **734** on inquiry card.

Resistors. New 20-page Bulletin LC-1030A pictures and describes maker's wire-wound encapsulated resistors.—Cinema Engineering Co., 1100 Chestnut, Burbank, Calif.

Circle **735** on inquiry card.

Boron Carbon Resistors. New 4-page Bulletin B-6a presents data and features of maker's boron carbon "Precistor" resistors.—International Resistance Co., 401 N. Broad St., Phila. 8, Pa.

Circle **736** on inquiry card.

Potentiometers. New 2-page illustrated bulletin describes maker's 1⅝" high-precision ganging potentiometers.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **737** on inquiry card.

Resistors. New 2-page bulletin pictures and describes maker's encapsulated precision wire-wound resistor.—RHO Engineering Co., 4205 Sepulveda Blvd., Culver City, Calif.

Circle **738** on inquiry card.

Potentiometer Checker. New 2-page specification sheet describes maker's "Model PC-15" potentiometer checker for calibrating and checking precision pots (voltage-dividing resistors).—Analogue Controls, Inc., 37 W. 20th St., New York 10, N. Y.

Circle **739** on inquiry card.

Precision Potentiometers. New 2-page bulletin pictures maker's "Series K-200" 2-in precision potentiometers used for low-torque, high-function-angle applications.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **740** on inquiry card.

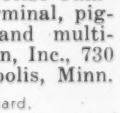
Resistors. New 8-page Catalog R-2 describes maker's "Precise-Ohm" fixed resistors, ferrule terminal, pigtail, adjustable, tapped and multisection resistors.—Precision, Inc., 730 Lyndale Ave., N., Minneapolis, Minn.

Circle **741** on inquiry card.

Tape Resistors. New 4-page Bulletin HEC-1 describes maker's tape resistors and their use in miniaturization and printed circuitry.—Hansen Electronics Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif.

Circle **742** on inquiry card.

RELAYS, SWITCHES



Electronic Relay. New 2-page bulletin describes maker's electronic overload relay.—Morrow Products, Inc., 3339 Forbes St., Pgh. 13, Pa.

Circle **743** on inquiry card.

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For more information circle **186** on inquiry card.

Switches. New 28-page Catalog 83 presents maker's line of enclosed switches used on alternating or direct current industrial applications.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **744** on inquiry card.

Relays. New 8-page leaflet presents specifications of maker's relays.—Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

Circle **745** on inquiry card.

Switches. Two new 2-page Data Sheets (104 & 105) describe maker's 2-circuit limit switch and double-pole, double-throw environment-free switch.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **746** on inquiry card.

Miniature Relays. New 4-page Bulletin GEA 6346 describes and illustrates maker's "2pdt" micro-miniature relay for electronic applications in aircraft, portable units, etc.—General Electric Co., Specialty Control Dept., Waynesboro, Va.

Circle **747** on inquiry card.

Switchboard. New 2-page bulletin describes maker's "Model 4A30" dial telephone switchboard for installations requiring 20 to 50 telephones.—Telecom, Inc., 1019 Admiral, Kansas City 6, Mo.

Circle **748** on inquiry card.

Sampling Switches. New 4-page brochure describes maker's highspeed multi-contact sampling switches.—General Devices, Inc., P. O. Box 253, Princeton, N. J.

Circle **749** on inquiry card.

Relays. New 4-page brochure describes maker's hermetically-sealed subminiature relays.—Filtors, Inc., Port Washington, N. Y.

Circle **750** on inquiry card.

Relays. Three new 2-page bulletins present specifications on maker's relays "100, 100-B, and 100-C" for more than 25 million operations.—Hedin Tele-Technical Corp., 640 W. Mount Pleasant Ave., Livingston, N. J.

Circle **751** on inquiry card.

CONNECTORS

Connectors. New 8-page issue of "Amphenol Engineering News" (Vol. 8, No. 4) describes maker's "Subminax" RF connectors, cable assemblies, etc.—American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill.

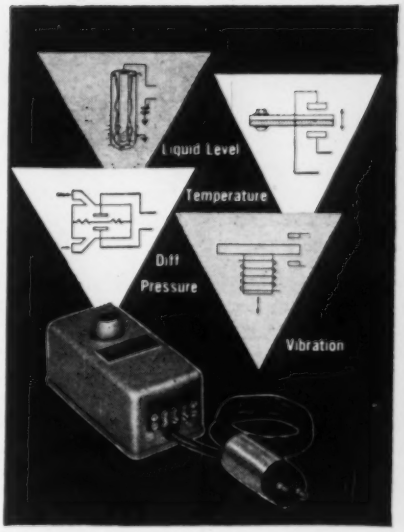
Circle **752** on inquiry card.

Cables and Connectors. New 4-page descriptive bulletin illustrates maker's microminiature coax cables and connectors.—Microdot Div., Felts Corp., 1826 Fremont Ave., So. Pasadena, Calif.

Circle **753** on inquiry card.

Connectors. New 8-page folder presents specifications on maker's miniature circular shielded connectors.—Viking Electric Div., 21343 Roscoe Blvd., Canoga Park, Calif.

Circle **754** on inquiry card.



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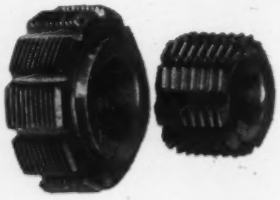

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NEW LITERATURE

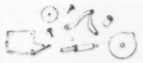
Connectors. New 4-page Bulletin 674-B "A New Approach to Connector Problems" features maker's electrical connectors and explains how many types of AN connectors can be built up from a few basic components.—Whitney Blake Co., Electronics Div., New Haven 14, Conn.

Circle **755** on inquiry card.

Electrical Connectors. New set of bulletins describe and illustrate maker's electrical connectors, fittings and clamps.—Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.

Circle **756** on inquiry card.

MECHANICAL COMPONENTS



Ball Bearings. New 24-page catalog describes over 500 standard radial ball bearings tabulated by bore size ranging from 0.250-in. to 0.2500-in.—Miniature Precision Bearings, Inc., Keene, N. H.

Circle **757** on inquiry card.

Instrument Bearings. New 4-page bulletin is an interchange table of instrument and miniature bearings of all makes.—Microtech Corp., 200 West Colorado St., Pasadena 1, Calif.

Circle **758** on inquiry card.

Helical Springs. New 12-page issue of "Mainspring" (Spring No. 16, Coil No. 2) features article on use of INCO nickel alloy helical springs.—Associated Spring Corp., Bristol, Conn.

Circle **759** on inquiry card.

Extension Spring. New 24-page illustrated booklet discusses development and applications of maker's constant-force extension spring.—Neg'ator Div., Hunter Spring Co., Lansdale, Pa.

Circle **760** on inquiry card.

ELECTRONIC COMPONENTS

Electronics Catalog. New 324-page "1956 Buying Guide" lists over 26,000 electronic parts and items.—Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle **761** on inquiry card.

Crystal Diodes. New 8-page Bulletin E-217 presents electrical and mechanical data on maker's germanium and silicon diodes.—CBS-Hytron, Danvers, Mass.

Circle **762** on inquiry card.

Transistors. Two new 2-page bulletins describe maker's small-signal silicon grown-junction transistors and silicon grown-junction medium-power transistors.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.

Circle **763** on inquiry card.

Insulated Conductors. New Bulletin 6A describes maker's high-temperature swaged magnesia-insulated conductors.—Aero Research Instrument Co., 1040 Grand Ave., Chicago 22, Ill.

Circle **764** on inquiry card.

Relays, Filters, Delay Lines. New 8-page Brochure 7-55-100 describes maker's research and development facilities in manufacture of maker's delay lines, antenna filters, relays, and pulse transformers.—Brubaker Electronics, Inc., 9151 Exposition Drive, Los Angeles 34, Calif.

Circle **765** on inquiry card.

Capacitors. New set of 2-page Bulletins (100, 101, 102, 103, 104 & 105) present electrical and physical data on maker's piston capacitors.—JFD Mfg. Co., Inc., Brooklyn 4, N. Y.

Circle **766** on inquiry card.

Capacitors. New catalog presents specifications on maker's ceramic capacitors, including disc types and special styles.—Solar Mfg. Corp., East 46th St., and Seville Ave., Los Angeles, Calif.

Circle **767** on inquiry card.

Inductors. New 4-page leaflet presents mechanical and electrical specifications on maker's toroidal inductors.—Torocoil Co., 1374 Mobile Ct., St. Louis 10, Mo.

Circle **768** on inquiry card.

TUBING, COUPLINGS

Pneumatic Couplings. New 4-page Bulletin 230 pictures and describes maker's "Snap-Tite Hi-Flow" coupling used to connect small air tools to plant air system, etc.—Snap-Tite, Inc., Union City, Pa.

Circle **769** on inquiry card.

Quick-connect Pneumatic Coupling. New 4-page Bulletin 551 presents maker's new "Quick-As-Wink" pneumatic line coupling for lines up to 250 psi, featuring knurled-sleeve on coupling which controls air in line.—C. B. Hunt & Son, Inc., Salem, Ohio.

Circle **770** on inquiry card.

Metal Hose. New 16-page Catalog 150 describes maker's lines of "Flexon" bellows and flexible metal hose.—Flexonics Corp., 1322 S. Third Ave., Maywood, Ill.

Circle **771** on inquiry card.

Metal Hose. New Catalog U-333 presents application data on maker's flexible metal hose products.—Universal Metal Hose Co., 2133 S. Kedzie Ave., Chicago 23, Ill.

Circle **772** on inquiry card.

Framing System. New 6-page folder pictures and describes maker's "Unistrut" metal framing system for support of tubing, etc.—Unistrut Products Co., 1013 W. Washington Blvd., Chicago 7, Ill.

Circle **773** on inquiry card.

Stainless-steel Tubing. New 8-page Catalog 11 describes maker's stainless-steel, nickel and nickel-alloy tubing.—J. Bishop & Co. Platinum Works, Malvern, Pa.

Circle **774** on inquiry card.

Steel Tubing. New series of charts present variation in load at yield of "Type 304" stainless-steel seamless tubing.—Crawford Fitting Co., 884 E. 140th St., Cleveland 10, Ohio.

Circle **775** on inquiry card.

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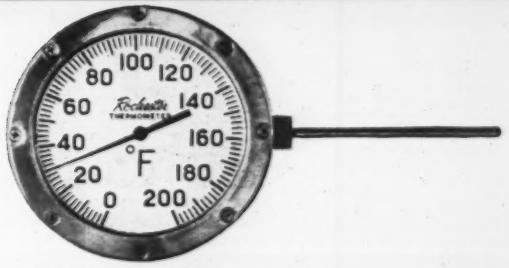

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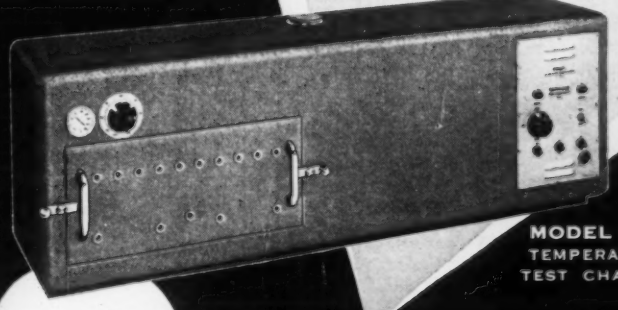

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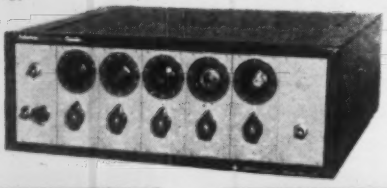

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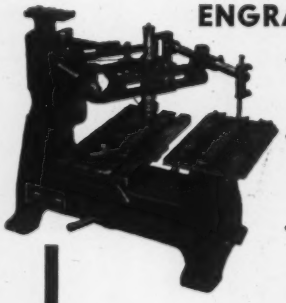

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NEW LITERATURE

MACHINERY

Coil Winding Machine. New 4-page folder describes maker's portable toroidal coil winding machine that meets both laboratory and production requirements.—Arnold Magnetics Co., 5362 Smiley Drive, Culver City, Calif.
Circle **776** on inquiry card.

Precision Machine Tools. New 8-page issue of "Hirschmann Highlights" (Sept. 1955) presents specifications on "Hauser's 3BA" jig borer, the "Tornos" swiss-type automatic screw machine, "Schaublin 102-80" lathe cabinet stand, etc.—Carl Hirschmann Co., Inc., 30 Park Ave., Manhasset, N. Y.
Circle **777** on inquiry card.

Machinery. New 54-page condensed catalog presents over 275 machines including automatic dieing machines, power presses and feeds, automatic glass container manufacturing machines, and automatic packaging equipment.—Emhart Mfg. Co., Hartford 2, Conn.
Circle **778** on inquiry card.

Pantograph. New 2-page bulletin pictures and describes maker's pantograph used for production work.—Mico Instrument Co., 80 Trowbridge St., Cambridge, Mass.
Circle **779** on inquiry card.

Drawing Instruments. New 64-page illustrated catalog presents maker's complete line of drawing instruments, drafting materials, templates, slide rules, stop watches, etc.—Compass Instrument & Optical Co., Inc., 104 E. 25th St., New York 10, N. Y.
Circle **780** on inquiry card.

Tool Holder. New 8-page Catalog GT-293 presents specifications of maker's tool holders for "throw-away" carbide insert blanks.—Carboloy Dept., General Electric Co., Detroit 32, Mich.
Circle **781** on inquiry card.

Rod Parter. New 14-page manual illustrates maker's "Di-Acro" rod parter which cuts round, square, rectangular and hexagon bar stock without rough edges or burr.—O'Neil-Irwin Mfg. Co. 665 Eighth Ave., Lake City, Minn.
Circle **782** on inquiry card.

Resistance Welder. Three new bulletins describes maker's "Weldmatic" (Models 1012, 1015 & 1020) precision resistance welders.—Unitek Corp., 275 N. Halstead Ave., Pasadena 8, Calif.
Circle **783** on inquiry card.

Ceramic Jig Blocks. New 2-page Bulletin 102 describes maker's "Sur-Braze" ceramic jig blocks for automating brazing operations.—Technion Design & Mfg. Co., Inc., 262 Mott St., N. Y. 12, N. Y.
Circle **784** on inquiry card.

Metal Bender. New 4-page folder describes maker's pneumatic power former used for bending strip metal, etc.—Car-Anth Mfg. and Supply Co., 411 Eichelberger, St. Louis 11, Mo.
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Stainless Fasteners. New 8-page bulletin is a condensed stock list of maker's stainless fasteners, screws, bolts, nuts, washers, threaded rods, etc.—Allmetal Screw Products Co., Inc., 821 Stewart Ave., Garden City, N. Y.

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MATERIALS

Metals & Alloys. New 24-page Technical Bulletin VM-101 presents technical data on vacuum-melted high-temperature alloys.—Carboloy Dept., General Electric Co., Box 237, Detroit 32, Mich.

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Diamond Abrasives. New 12-page Booklet 2 "Metallographic Polishing With Diamond" has application to specimen polishing of metallic carbides and other metals.—Elgin National Watch Co., Elgin, Ill.

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Glass-to-metal Seals. Five new 2-page Data Memorandum 15 sheets describe maker's six glass sealing alloys. Includes data on production limits, nominal chemical analysis, temper ranges, etc.—Superior Tube Co., 1565 Germantown Ave., Norristown, Pa.

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Ball & Socket Beads. New 4-page leaflet pictures and describes maker's ball and socket beads in patented package designed to save 75% in assembly costs.—Saxonburg Ceramics, Saxonburg, Pa.

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Mica Insulation. New 14-page Catalog M-55 describes maker's "Micabond" bonded mica insulation.—Continental-Diamond Fibre Div., Budd Co., Inc., Newark, Dela.

Circle **791** on inquiry card.

Lubricant. New 2-page Bulletin 101 describes maker's "Type BR2 Molykote" multi-purpose grease.—Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn.

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Stainless Steel. New 10-page booklet presents information on maker's "AM 350" chromium-nickel-molybdenum stainless steel.—Allegheny Ludlum Steel Corp., 2020 Oliver Bldg., Pgh. 22, Pa.

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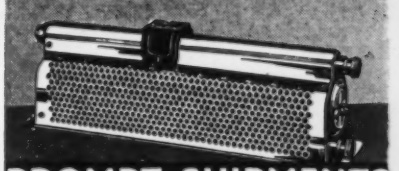

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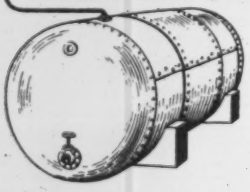
UEHLING TANK-O-METER



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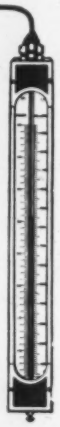
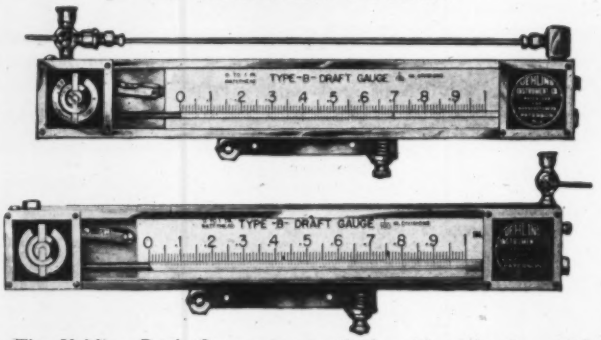


TANK-O-METERS may be applied to the measurement of ACIDS, ALKALIS, WATER, OIL, GASOLINE, ALCOHOL, BEVERAGES, TAR, MOLASSES, MILK, PAINTS, VARNISHES, SODIUM SILICATE, SOLVENTS, OR ANY OTHER CHEMICAL SOLUTION. *Send for Bulletin No.* 945.

INCLINED DRAFT GAUGES
For Plus or Minus Pressure
For Differential Pressure



The Uehling Draft Gauges are available with scales from 10″ to 40″ and waterheads ranging from 1″ to 8″. Scales are graduated for every 1/100″ of waterhead. Each instrument is housed in a durable aluminum case with glass front and adjustable scale. They are extremely accurate as each instrument is individually calibrated. Furnished for draft, pressure, or differential pressure. *Send for Bulletin* 1146.

U-TUBES
(STRAIGHT TUBE TYPE)

Uehling U-Tube Pressure and Vacuum Gauges consist of straight Pyrex tubes with a bottom metal connecting base, housed in aluminum case with glass front.

Each instrument has an external micrometer scale adjustment, zero check cock, and drain valve.

Scale lengths from 10″ to 100″.

Four indicating fluids.

Special calibration on request.

Send for Bulletin 828.

TEL-FLO METER

For measuring flow rates and purging line. Are accurate, exceptionally durable, and attractive. Housed in aluminum case with plastic front to protect graduated glass tube. Can be furnished in aluminum, brass, or stainless steel bodies (or any other metal). Suitable for maximum pressures of 300 lbs. Higher pressures upon request. Furnished with or without control valve and with either top, side, or back connection.

Send for Bulletin 553.

MERCURIAL BAROMETERS

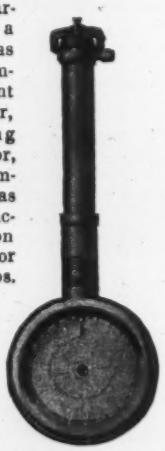
With vernier scale. Can be furnished with the same style case as used with Uehling pressure and vacuum gauges, illustrated here.

PRESSURE AND VACUUM GAUGES

Meet the most exacting requirements and combine accuracy, reliability, simplicity and durability. Housed in durable Aluminum cases with glass fronts. Standard instrument covers a range of 31 inches of mercury head. A catch-all for trapping visibly shows any condensate in the connecting line. Each scale has a knurled micrometer screw adjustment. A simple means is provided for cleaning the Pyrex manometer. May be calibrated in any desired units for pressure or vacuum and may be provided with a plus or minus scale to read either vacuum or pressure on the same instrument. Length to suit any range. Greater flexibility is made possible by choice of either mercury or one of three other indicating fluids.

Send for Bulletin 147.

APEX CO_2 RECORDER



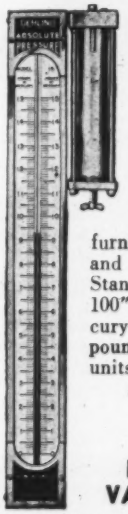
Actuated by changing partial vacuum developed in a separate device, known as the CO_2 meter. The complete standard equipment consists of one CO_2 Meter, one type M Recording Gauge, one type Z Indicator, "Pyro-Porus" filter, one sampling pipe holder, one gas dryer, one motor driven vacuum pump and one suction regulator. Where steam or water is available at 60 lbs. pressure or more, an aspirator may be substituted for the motor driven vacuum pump which materially reduces the price of the equipment. The Apex CO_2 Recorder makes a continuous record.

Send for Bulletins 118 *and* 118E.

Visit us at Booth 418 at the Automation Show.

For more information circle **201** on inquiry card.

MERCURY COLUMN ABSOLUTE PRESSURE INDICATORS



Uehling Mercury Column Absolute Pressure Gauges are designed for exacting requirements of modern engineering practice, and combine accuracy, reliability, simplicity, and durability. Used with all processes where extremely accurate absolute pressure determinations are essential. Can furnish catch-all for trapping and showing any condensate. Standard scale lengths of 7″ to 100″, graduated in 1/10″ of mercury absolute pressure or in pounds or in equivalent metric units.

Send for Bulletin 247.

COMBINED BAROMETER AND VACUUM RECORDER

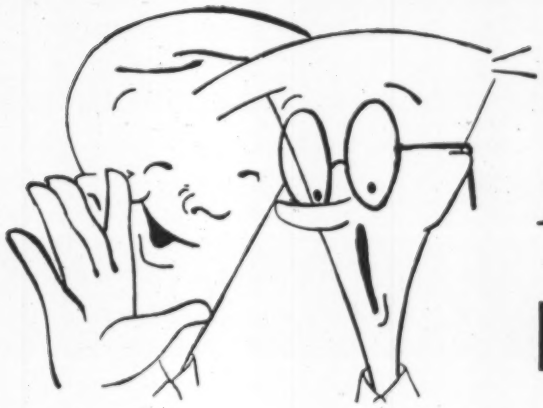
Records barometric pressure and vacuum on same chart. Distance between the two recorded lines represents the absolute pressure. Permanent accuracy and remarkable legibility are the outstanding characteristics of this recorder. Accuracy is obtained by the employment of the mercury column principle and consequently this recorder has the same high degree of accuracy as the mercury column indicator. It employs no springs, diaphragms, or multiplying levers, therefore holds its calibration permanently without readjustment.

Send for Bulletin 150.

UEHLING VACUUM RECORDER

Same as above, without barometric pen.

Send for Bulletin 140.



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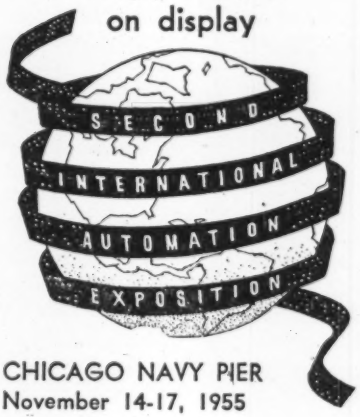

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*as of September 1st.

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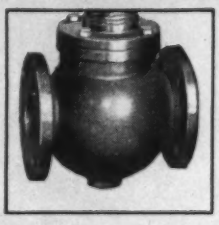
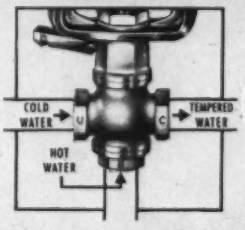
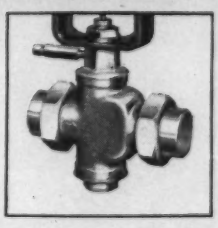
POWERS No. 11 Self-Operating TEMPERATURE REGULATOR

Automatically holds temperature constant at the right point.
Prevents losses caused by wasteful OVER-heating.





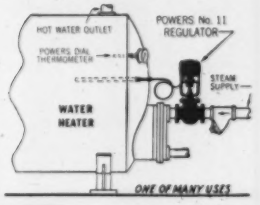


Various Valve Bodies and Inner Valves are available. Single and Double Seat Valves thru 2" have rugged bronze bodies with bronze union connections for quick, easy installation. Bulletin 329 gives information about all types.

(c33)

Why It Gives BETTER CONTROL and Saves More Money

Often repays its cost 3 to 6 times a year when used on:



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Industrial Processes
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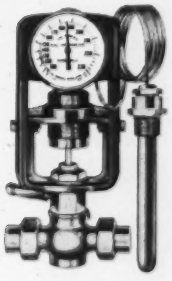
ONLY POWERS No. 11 REGULATOR Offers ALL These Advantages

- **Simple, sturdy construction.** Materials used are corrosion resistant.
- **Powers bellows has 50% more power** than used in the majority of regulators. The heart of a self operating regulator is its bellows. Powers with its 50% greater effective area gives better control and its durable 2 ply bellows outlasts ordinary single ply bellows.
- **Valve stem lubricator** with silicone grease aids easy movement of highly polished stainless steel valve stem and reduces drying out of packing.
- **BETTER CONTROL** results from Powers powerful bellows and minimum of valve stem friction.
- **60°F. temperature ranges** available with accuracy of ±1°F. on some processes and 2 to 3°F. on others.
- **Rugged bronze valve bodies with bronze union connections,** for single and double seat valves thru 2", reduce installation time and labor. Larger sizes have flanged iron body valves.
- **Powers Nationwide Service and 24 Hour Delivery** in the U.S.A. are important time and money saving advantages.



- **Indicating Regulator** with easy to read 4" dial thermometer helps adjust the regulator and check temperature at the bulb. Various dials and ranges are available.

Right type and size of valve is important for good control. May we help you make the right selection? Benefit from POWERS more than 60 years experience with self-operating regulators.

Call our nearest office or write us direct for Bulletin 329.

THE POWERS REGULATOR CO.

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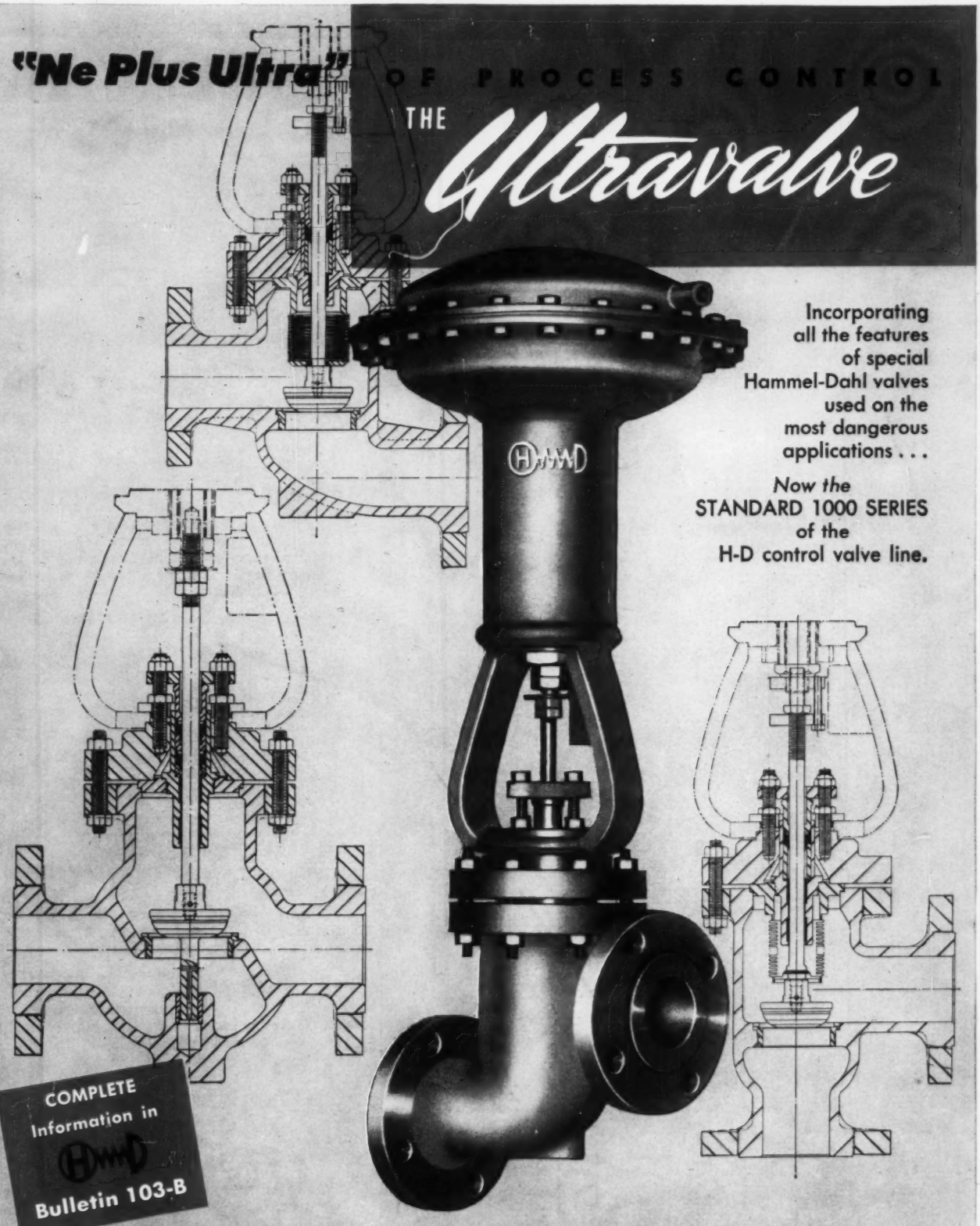
THE *Ultravalve*



Incorporating all the features of special Hammel-Dahl valves used on the most dangerous applications . . .

Now the
STANDARD 1000 SERIES
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COMPLETE Information in H-D Bulletin 103-B

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